USDA/STATE/EPA ASSESSMENT TEAM OF THE
NATIONAL AGRICULTURAL PESTICIDE IMPACT ASSESSMENT PROGRAM
UNITED STATES DEPARTMENT OF AGRICULTURE

ECONOMIC ANALYSIS OF ETHYLENEBISDITHIOCARBAMATE (EBDC) FUNGICIDE USES IN AGRICULTURE

Sections I-VI

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3/31/80

EBDC
Sect. I-VI
Economic Analysis

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INTRODUCTION AND SUMMARY

PURPOSE OF ANALYSIS

This report is a preliminary economic impact analysis of cancellation of a group of fungicides called EBDC's. The EBDC's include amoban, zineb, maneb, nabam, mancozeb, and metiram. This analysis is intended as an input to the risk/benefit decision by the Administrator of EPA as to the continued registration of the EBDC fungicides under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended (FIFRA)(7 U.S.C. 135, et seq). This report also incorporates the factors to be considered and procedures to be utilized in assessing economic impacts as described in the EPA Administrator's "Interim Guideline For Economic Impact Analysis of Proposed Regulatory Actions to Control Carcinogenic Pesticides."

A notice of rebuttable presumption against registration (RPAR) of the EBDC fungicides was issued in the Federal Register on August 10, 1977. If the data on human health risks cited in the RPAR notice are not successfully rebutted, the Administrator shall consider the economic benefits of continued use of the pesticides in question in order to determine if the risk might be offset by the benefits. This report analyzes the benefits of the EBDC fungicides.

Table 1

SUMMARY OF ECONOMIC IMPACTS OF CANCELLING
THE EBDC FUNGICIDES

Use Site	Extent of Use: Pounds Active Ingred.	Extent of Use: Units Treated: Percent	Extent of Use: Units Treated: Acres	Availability of Economic Alternatives	Economic Impacts: Nature	Economic Impacts: Extent ($/year)	Economic Impacts: Significance
Apples	4,600,000	35.0	184,000	yes	yield, cost	$10,000,000	minor
Bananas	N/A	100.0	N/A	yes1/	yield, cost	$17,000,0003/	moderate
Plums/Prunes	32,000	2.0	2,300	yes1/	cost	$ 48,000	minor
Citrus	500,000	5.0	79,000	yes1/	gain	$ 800,000	minor
Grapes	60,000	2.5	17,000	yes1/	yield, cost	$ 3,000,000	minor
Other Fruit	366,000	4.8	36,300	yes1/	cost	$ 283,000	minor
Cabbage	110,000	18.6	19,600	yes	cost	$ 262,000	minor
Cucurbits	1,600,000	35.0	184,500	yes	cost	$ 5,300,000	minor
Potatoes	6,200,000	53.0	1,156,000	yes	cost	$ 4,500,000	minor
Lettuce	260,300	29.1	68,000	yes2/	yield, cost	$51,000,000	major
Celery	250,000	43.1	14,760	yes	cost	$ 761,000	minor
Mushrooms	181,000	63.0	31.0 mil5/	yes	yield, cost	$ 2,500,000	moderate
Onions	840,000	25.0	52,600	yes	cost	$ 480,000	minor
Snap Beans	457,500	40.0	37,500	yes	cost	$ 1,834,000	slight
Spinach	43,000	59.0	6,000	yes2/	yield	$ 5,000,000	moderate
Sweet Corn	770,000	37.6	58,300	yes	cost	$ 1,400,000	moderate
Tomatoes	2,600,000	30.0	151,140	yes	cost	$10,500,000	minor
Lima Beans	31,000	7.3	4,800	none	yield	$ 380,000	minor
Green Peppers	120,000	22,2	12,800	yes	yield, cost	$ 5,700,000	moderate
Xmas Trees/ Pine Nurseries	100,000	Unk	11,000	yes	yield, cost	$ 600,000	moderate
Flower/Foliage Plants	Unk	100.04/	9,000	yes	yield, cost	$ 357,000	moderate
Turf	516,000	Unk	1.9 mil6/	yes	cost	$ 450,000	minor
Grass Seed		18.5	50,000	no	yield	$ 8,000,000	major
Peanuts	2,300,000	14.4	273,000	yes	cost	$ 2,900,000	minor
Tobacco	26,050	33.0	28.5 mil7/	yes	yield, cost	$ 1,400,000	minor
Wild Rice	96,000	90.0	15,000	none	yield loss	$ 3,200,000	major
Small Grains	5,600,000	1.8	1,400,000	none	yield loss	$ 8,800,000	minor
Industrial Uses							

1/ Some alternatives are under RPAR review.

2/ Alternative is phytotoxic and may cause quality loss.

3/ Bananas are primarily an imported commodity. Economic impact listed is to U.S. consumers of bananas.

4/ Data is for Florida growers only.

5/ Units are in square feet.

6/ Units are in thousands of square feet.

7/ Units are in square yards.

SCOPE AND APPROACH

This report is on a use-by-use basis covering those uses identified as significant in term of EBDC's applied or for which EBDC's were thought to be essential. Where possible this report identifies the major and minor uses of the pesticides; estimates quantities utilized; identifies registered alternatives; determines the change in production costs associated with the use of alternatives; determines the changes in yields and quality of agricultural commodities when alternatives are used; and evaluates the regulatory impact upon crop production, farm level prices, and retail prices. The economic impacts on users of EBDC fungicides and consumers of EBDC-treated commodities are considered on state/region level and at the United States level as appropriate.

The time frame for this analysis is for 1977. For almost all uses analyzed, a 1974-1976 data base was used to make necessary projections on commodity production and prices. Data on the extent of EBDC fungicide use was provided by a USDA/State/EPA Assessment Team which consisted of persons knowledgeable in the use of EBDC fungicides on the various crops covered in this report.

SUMMARY

Table 1 summarizes the usage data and economics of the EBDC fungicides.

DRAFT

ECONOMIC IMPACT ANALYSIS OF CANCELLING THE EBDC FUNGICIDES

U.S. ENVIRONMENTAL PROTECTION AGENCY

AND

U.S. DEPARTMENT OF AGRICULTURE

JANUARY 1979

I

SECTION I.

A. APPLES
B. MISCELLANEOUS
C. PLUMS AND PRUNES
D. CITRUS
E. GRAPES

APPLES

Introduction

Approximately 507,300 acres of apples are grown in the U.S. (Table I-1). Fungal rot losses are more seriouse in areas which have a number of warm moist days during the growing season. Therefore, these fungal rots are more of a problem in the eastern portion of the U.S. The growing conditions experienced in New York and Michigan, two major producing States in the east, are generally cooler and more favorable to apple scab than fruit rots. In the western portion of the U.S., climatic conditions are generally not conducive to the growth of fungi during the critical portions of the growing season (1).

The impact upon the eastern portion of the nation is best analyzed by viewing it as 3 separate regions: the Southeast; a combination of the mid-Atlantic and Midwest; and the Northeast. These regions are homogeneous areas based upon climatic conditions, pest distributions or cultivars grown.

Apple Disease Problems

Northeast:

There are about 167,000 acres of apples in this region with an average annual production of about 1.8 billion pounds (1, p. 156). The region also includes states of Michigan and New York which have a similar climatic condition, pests or cultivars to the North East. Apple scab is the major disease. EBDC's are used along with captan to control apple scab in areas where resistance to benomyl or dodine (not EBDC's) has been encountered.

In the Northeast, the necessity of the EBDC's lies in their value in integrated pest management programs. EBDC's are considered necessary because of expected resistance to benomyl. In this region, the difference in efficacy and cost between the EBDC's and their alternatives was not considered great enough to warrant separate economic analysis. The importance of their use can, however, be seen in the Biological Assessment (1, p. 144-145).

Mid-Atlantic and Midwest:

Apples are grown on about 96,000 acres in the mid-Atlantic region and on about 39,000 acres in the Midwest region (Table I-1). Average annual production in these two regions is about 1.56 billion pounds--1.22 billion pounds in the mid-Atlantic region and 340 million pounds in the Midwest region. The major diseases include scab, powdery mildew, rusts, and fruit rots (1, p. 134-135). EBDC's are desired in the region because they (1) provide broad spectrum control, (2) leave an acceptable fruit finish, (3) are compatible with most insecticides and fungicides, and (4) are nontoxic to the beetle (Stethorus punctum) a predator of mites.

It was assumed that an equally effective alternative fungicide spray program could be adopted which would not use the EBDC fungicides. Therefore, it was assumed that there would be no change in apple production in the regions if EBDC use is cancelled.

Southeast:

Bitter rot is considered the most damaging disease of apples in the Southeast. Other fungal rots also exist but would be prevented by spraying for bitter rot. Apples are produced on 33,000 acres in the region with average annual production at 342 million pounds (Table I-1).

User Impact

The economic impact resulting from the cancellation of the EBDC fungicides would vary by region. In the Southeast, there would be an increase in fungus control costs and a decrease in apple production. In the mid-Atlantic and Midwest regions, there would only be an increase in fungus control costs because it was assumed that the alternative control program to EBDC was equally effective.

Southeast:

It was estimated that about 83 percent of the apple acreage, or 27,390 acres are treated with EBDC fungicides annually (Table I-1). Dikar®, a product containing 72 percent mancozeb and 4.7 percent dinocap, is the most widely used fungicide in apple production. Mancozeb is an EBDC fungicide. A test to determine the relative efficacy of Dikar® and its

main alternative folpet was conducted in North Carolina in 1976 (1, p. 147). This test is considered representative of field conditions and commerical application equipment was used: The results of the test were as follows: no fungicidal spraying -- 60 percent yield loss; spraying with the alternative folpet -- 30 percent loss; and spraying with the EBDC - Dikar® -- 2 percent loss.

As many as 11 or more applications per season are needed to prevent infection of apples with bitter rot and other disease (1, p. 147). Based on 11 applications per season, a Dikar® treatment program costs $112 per acre compared to the alternative, folpet, at $118 per acre — or a cost increase of $7 per acre if the use of the EBDC fungicides is cancelled (Table I-2). For the region, this would amount to an impact of $192,000 on the 27,390 acres of apples treated with an EBDC fungicide (Table I-1).

In addition growers in the Southeast would experience a yield reduction if the EBDC fungicides are cancelled. In the biological test discussed earlier. Fruit loss was estimated at 30 percent when folpet was used compared to 2 percent for Dikar®. This 28 percent difference in production could result in a loss of 96 million pounds of apples (Table I-1). The average price per pound paid to apple growers in the region during 197476 was approximately 8 cents (Table I-3). The estimated loss in apple production would result in a $7.7 million reduction in annual income to apple growers in the region.

Due to the nationwide marketing of apples, it was assumed that growers in the region would not experience substantially higher local prices for their remaining apples. The local supply, it was assumed,

would be supplemented by other areas. Additionally, the loss of 96 million pounds of apples is not expected to have any appreciable effect on annual national apple prices because it only represents 1.4 percent of average annual apple production. However, South Carolina and Georgia are presently able to supply fresh apple to the national market before most production areas come to harvest. The effect of the reduced production upon apple price during the first few weeks of harvest was not calculated. A portion of the effect is overridden by supply of stored apples from the Western States.

Shifts in regional apple acreage are not expected in the short-run. Heavily impacted apple cultivars would not be ripped out or abandoned (liquidation of the capital investment) until conditions reached a point where the grower was not covering his variable or cash production expenses.

Mid-Atlantic and Midwest:

It was estimated that 90 percent of the apple acreage in the mid-Atlantic region (86,085 acres) and 75 percent (29,137 acres) in the Midwest region is treated annually with EBDC fungicides (Table I-1).

To estimate the impact of an EBDC cancellation on fungus control costs, a hypothetical spray program was developed by the Assessment Team (Table I-4). Dikar® was assumed to be used for all disease control applications except the last cover spray when zineb (an EBDC) and captan would be applied as a mixture.

The alternative disease control program contains several fungicide materials and would require apple growers to have a broader knowledge of fungicides and could also present fungicide handling and storage problems.

The alternative spray program would necessitate one additional application (cover) of captan if the last zineb application was eliminated. It

[illegible] by other means. Additionally, the loss [illegible]

pound of apples is not expected to have a [illegible]

[illegible] apple prices because [illegible] only represents 1.1 percent of [illegible]

[illegible] apple production. However, much [illegible] would [illegible]

[illegible] able to supply fresh apple to the national market [illegible]

[illegible] areas come to harvest. The effect of the reduced [illegible] supplies [illegible]

[illegible] during the first few weeks of harvest [illegible]

the effects is [illegible]

Improved apple cultivars [illegible]

[illegible] of the capital investment [illegible] existing orchard [illegible]

[illegible] grower was not operating [illegible]

Midwest:

[illegible] estimated that [illegible] percent of the apple acreage in the

[illegible] region (36,631 acres) and [illegible]

[illegible] is treated annually with [illegible] (Table [illegible])

[illegible] are the impact of [illegible] cancellation on [illegible]

[illegible] chemical spray program was developed by [illegible]

[illegible] was assumed to be used for all [illegible]

[illegible] cover spray when [illegible] (on [illegible]) and [illegible]

[illegible]

[illegible] control program [illegible]

[illegible] to have a broader [illegible]

[illegible] present [illegible]

[illegible]

would also necessitate an additional spraying of a miticide (for example cyhexatin or dicofol) at some time during the growing season. Cyhexatin was assumed to be the material of choice based on use preference of growers although dicofol was the least expensive alternative. An analysis of both alternatives was made.

If the EBDC fungicides are cancelled, it is estimated that disease control costs would increase as much as $15.46 to $18.22 per acre depending on which miticide was used in the alternative control program (Table I-5). The total economic impact on the 115,000 acres treated with EBDC fungicides in the mid-Atlantic and Midwest regions would range from $1.8 million to $2.1 million. This additional cost is assumed to be borne by the producers.

Consumer Impact

The impact on retail apple prices is difficult to determine because of the naturally occurring wide variation in annual production. Apples can be held in storage and are marketed on a national basis. The estimated loss of 96 million pounds of apples in the Southeast without EBDC fungicides is only 1.4 percent of average annual production and not expected to affect retail prices.

Table I-1. Apple acreage production, and acreage treated with EBDC fungicides

Region and State	Acreage of apples a/	Average annual production b/	Percent of acreage treated with EBDC c/	Acreage sprayed with EBDC
	acres	mil. lbs.		
Southeast				
North Carolina	18,500	271.0		
South Carolina	2,900	22.4		
Georgia	7,000	22.0		
Tennessee	2,700 d/	7.7		
Arkansas	1,900 d/	18.5		
Total	33,000	341.6	83	27,390
Mid-Atlantic				
Pennsylvania	34,600	464.0		
New Jersey	7,900	115.0		
Delaware	800 d/	12.1		
Maryland	5,850	69.8		
West Virginia	18,000	216.0		
Virginia	28,500	344.0		
Total	95,650	1,220.9	90	86,085
Midwest				
Illinois	12,000	94.2		
Ohio	11,150	113.4		
Missouri	8,000	63.3		
Indiana	5,200	54.8		
Kentucky	2,500 d/	14.4		
Total	38,850	340.1	75	29,137
3 region total	167,500	1,882.6	85	142,612
U.S. total	507,300 d/	6,700.0	--	--

a/ Data from most recent State surveys (1972-1976) unless noted.
b/ Five-year averages (1973-1977), Statistical Reporting Service, USDA.
c/ Estimated by the Biological Assessment Team..
d/ Data from 1974 Census of Agriculture-State Miscellaneous Data, Table 1, page 111-29. (Data not available from State surveys.)

Table I-2. Per acre treatment costs for Dikar® (an EBDC) and Folpet, its most effective alternative, Southeast region a/

Fungicide	Number of applications per season	Pounds of material per application b/	Material cost per pound c/	Total cost per acre per season
Dikar® d/	11	8	1.27	111.76
Folpet e/	11	8	1.35	118.80
Cost increase				7.04

a/ Based on information from the "Assessment of EBDC Fungicide Uses in Agriculture", USDA/State/EPA Assessment Team, September 1978, p. 147.

b/ Pounds of formulated product mixed at 2 pounds/100 gallons water and applied at a rate of 400 gallons per acre.

c/ Typical grower prices for 1977.

d/ 72 percent mancozeb and 4.7 percent dinocap.

e/ 50 percent wettable powder.

Table I-3. Apples: Average price per pound, 1974-76, southeastern States a/

State	Year 1974	1975	1976	Average for 1974-76
	----------	dollars per cwt.	----------	----------
North Carolina	6.20	5.90	9.10	7.07
South Carolina	10.30	10.10	10.40	10.27
Georgia	-	-	9.20	9.20
Tennessee	10.40	10.60	10.90	10.63
Arkansas	11.50	7.60	11.10	10.17
Total				7.61 b/

a/ USDA, Agricultural Statistics, 1977, Washington, D. C. 1977, Table 282, p. 207.

b/ Weighted by average annual production for each State 1974-1976, State Surveys and SRS data.

Table I-4. Apples: Mid-Atlantic and Midwest Regions, a hypothetical disease control program for EBDC and the alternatives to replace EBDC if it is cancelled a/

Fungicide applied	Sprayings				Covers							Added cover	Added miticide
	Delay dormant	Pre-pink	Pink	Petal fall	1st	2nd	3rd	4th	5th	6th	7th		
	pounds b/												
EBDC													
Dikar®c/	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5.0	5.0	5.0			
Zineb											3.2 d/		
Captan											3.2 d/		
Alternative e/													
Benomyl	.5	.5	.5										
Oil f/	2.0	2.0	2.0										
Thiram		1.6	1.6	1.6	1.6	1.6	1.6						
Dinocap				1.6	1.6	1.6	1.6						
Captan				6.5	6.5	6.5	6.5	5.0	5.0	5.0	4.5	4.5	
Cyhexatin													0.75
or													
dicofol													3.2

a/ Developed by the EBDC Assessment Team based on their knowledge of disease control problems and the 1977 Tree Fruit Production Guide, Pennsylvania State University, 1977.
b/ Formulated product.
c/ 72 percent mancozeb and 4.7 percent dinocap.
d/ Sprayed as a mixture.
e/ Chemicals listed in each column would be used together.
f/ Quarts of oil.

Table I-5. Apples: Mid-Atlantic and Midwest Regions--Material costs per acre for a hypothetical EBDC spray program and an alternative program if EBDC use is cancelled a/

Fungicide applied	Sprayings: Delay dormant	Pre-pink	Pink	Petal fall	Covers: 1st	2nd	3rd	4th	5th	6th	7th	Added cover	Added miticide	Increased cost per acre
	dollars													
EBDC														
Dikar® b/	8.25	8.25	8.25	8.25	8.25	8.25	8.25	6.35	6.35	6.35				
Zineb											3.90 c/			
Captan											3.04 c/			
Total	8.25	8.25	8.25	8.25	8.25	8.25	8.25	6.35	6.35	6.35	6.94			
Alternative														
Benomyl	3.65	3.65	3.65											
Oil	.76	.76	.76											
Thiram		2.16	2.16	2.16	2.16	2.16	2.16							
Dinocap				3.82	3.82	3.82	3.82							
Captan				6.17	6.17	6.17	6.17	4.75	4.75	4.75	4.28	6.28 b/		
Cyhexatin													11.00 c/	
or														
dicofol													8.24 c/	
Total	4.41	6.57	6.57	12.15	12.15	12.15	12.15	4.75	4.75	4.75	4.28			
Difference in cost	-3.84	-1.68	-1.68	+3.90	+3.90	+3.90	+3.90	-1.60	-1.60	-1.60	-2.66	+6.28	+11.00 or +8.24	15.46 to 18.22

a/ Based on the application rate per spraying presented in Table I-4 and the following fungicide prices developed by the Assessment Team based on their knowledge of the pesticide market and manufacturers' price lists. The price per pound of formulated product is as follows:

Dikar® - $1.27 b/	Benomyl - $7.30	Cyhexatin - $12.00
Zineb - 1.22	Thiram - 1.35	Dicofol - 1.95
Captan - .95	Dinocap - 2.39	Oil (per qt.)- .38

b/ 72 percent mancozeb and 4.7 percent dinocap.

SUMMARY OF ECONOMIC IMPACT ANALYSIS
EBDC USE ON APRICOTS, BANANAS, CHERRIES, NECTARINES, PEACHES, PEARS, ALMONDS, PECANS

A. USE: Use of EBDCs (mancozeb, maneb, metiram, nabam, zineb) to control various diseases of stone and pome fruits and tree nuts.

B. MAJOR PESTS CONTROLLED: Apricots-brown rot, green rot, leaf spot, shothole; bananas-sigatoka; cherries-leaf spot, shothole; nectarines and peaches - brown rot, shothole, leaf curl, leaf spot, scab; pears-bitter rot, black rot, brown rot, fire blight, flyspeck, rust, scab, sooty blotch, pear psylla (an insect); almonds-brown rot, leaf spot, scab, shothole, twig blight; pecans-scab.

C. ALTERNATIVES:

Major recommended chemicals: Based upon the number of states recommending specific fungicides, the following chemicals are considered to be major alternatives for the crops in question if EBDCs are unavailable.

alternative	apricots	bananas	cherries	nectarines	peaches	pears	almonds	pecans	pear psylla on pears
benomyl*	X	X	X	X	X	X	X	X	amitraz* (if available), endosulfan, phosmet
bordeaux				X	X		X		
calcium polysulfide				X	X				
captafol*			X						
captan*	X		X	X	X	X	X		
coppers	X		X	X	X		X		
dichlone			X		X		X		
dichloran				X	X				
dodine			X			X		X	
ferbam			X	X	X	X			
folpet*			X						
petroleum oils		X							
sulfur	X		X	X	X				
thiophanate methyl*		X							
triphenyltin hydroxide								X	

*=RPAR or candidate for RPAR.

Non-chemical controls: Orchard sanitation practices (removal of drops, pruning infected limbs, etc.) aid in preventing spread of diseases but do not control them once established. No IPM or cultural controls exist for pear psylla.

Comparative costs: Treatment costs vary considerably by crop and disease, and are influenced by regional price differences for fungicides, a wide range in application rates, and method of treatment. In most cases, certain alternatives are more expensive and some are less expensive to use than EBDC materials.

Conclusion: Loss of EBDCs will lead to greater reliance upon alternatives, particularly benomyl. Reduction in number of effective fungicides will reduce grower flexibility and probably increase the rate of development or spread of disease resistance or tolerance to currently available fungicides.

D. EXTENT OF USE:

crop	EBDC used[1/]	quantity a.i. applied: per acre-treatment	per acre	total	acres treated	acres treated as % of acres grown
apricots	maneb	4.8	4.8[2/]	4,400	900	3
bananas	mancozeb	1.2	14.4	-		100[3/]
cherries	nabam, zineb			little	few	neg.
nectarines	maneb	5.0	5.0[2/]	1,100	220	1
peaches[4/]	maneb	5.0	5.0	13,500	2,700	3
pears						
diseases	mancozeb	4.8	10.3	36,000	3,500	3
pear psylla	mancozeb	7.2	7.2 - 14.4	289,000	25,000	24
almonds	maneb	5.5	5.5[2/]	22,000	4,000	1
pecans	metiram	-		little	few	neg.

1/ Maneb is assumed to be the major EBDC used on apricots, nectarines, peaches and almonds. Small amounts of other EBDC's may also be used on these crops.

2/ Assumes one (1) EBDC spray per season.

3/ Extent of EBDC use unknown but it is reasonable to conclude all bananas imported into the U.S. are treated due to disease problems in producing countries.

4/ Data for California only; small amounts of EBDC's probably are used in other states.

E. ECONOMIC IMPACTS:

User:

In the short term, cancellation of EBDC's will cause minor cost increases as producers utilize alternative fungicides. The following aggregate cost increases are projected (annual basis), reflecting the use of a mix of generally higher-cost alternatives:

apricots: $3,600 incurred by growers.

bananas: no domestic grower-level effect since all bananas are imported

cherries: little or no grower impact due to lack of EBDC use.

nectarines and peaches: $10,000 incurred by growers.

pears—diseases: $15,000 incurred by growers.
pear psylla: $231,000 incurred by growers.

almonds-$24,000 incurred by growers.

pecans-little or no grower impact due to lack of EBDC use.

Although the immediate cost impacts associated with the unavailability of EBDC's for use on these fruits and nuts are relatively minor, the long-term economic implications of the cancellation of EBDC s extend beyond the costs of alternatives. The major benefit derived from the use of EBDC's on these crops concerns the avoidance or minimization of the continuing problem of resistance or tolerance to first-choice fungicides, particularly benomyl. EBDC's are probably used by growers experiencing difficulty in controlling diseases with other materials and/or by growers using a multi-fungicide rotation program to avoid resistance. Benomyl, the first-choice fungicide for many diseases attacking fruits and nuts, is susceptible to resistance buildup within a few years after its first use if applied frequently. In California, widespread reliance on benomyl during the past several years is reported to have caused severe control problems, particularly in peach orchards. Resistance to benomyl is considered a likelihood, if not a certainty, on fruit and nut crops if it is used exclusively or predominantly. Although growers would not be expected to rely solely upon EBDC's if benomyl resistance becomes widespread, the EBDC's would be major alternatives, particularly in view of the RPAR status of other materials such as captan, captafol, and folpet.

Consumer:

Consumers will not be affected in the short run by a cancellation of EBDC's for use on the fruit and nut crops in question. In the long run, the reduction in effective fungicides caused by cancellation may result in reductions in quality and yield. Consumer prices would increase as the supply of apricots, nectarines, peaches, pears and almonds declines. Cherry and pecan production levels would be affected the least of the group examined. A combination of two factors- 1) disease resistance or tolerance to alternative materials which are currently rotated or combined with EBDCs (particularly benomyl) and 2) RPAR actions resulting in cancellation of alternative fungicides - - would greatly increase the importance of EBDCs. Retail prices for bananas are projected to increase by as much as 26 percent due to yield reductions of up to 20 percent in producing countries if the EBDC tolerances are revoked on bananas (the remaining banana fungicides are petroleum oil, benomyl, and thiophante methyl - - latter two RPARS).

F. LIMITATIONS OF ANALYSIS:

Little current usage data is available to evaluate the importance of EBDC's to production of these crops. Analysis assumes equal control with alternatives in the short run. Long term effects cannot be reliably determined.

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EPA, December, 1978.

Apricots

Three types of EBDC fungicides (maneb, nabam, zineb) are registered for use on apricots (Table I-6). EPA Registrations of EBDCs for various apricot diseases are as follows: brown rot (maneb); green rot (maneb); shot hole (maneb, zineb); leaf curl (nabam, zineb). A review of state pesticide recommendation guides indicates that EBDC's are not widely recommended for control of apricot diseases (Table I-7). In California, which accounts for almost all (97.5%) domestic apricot production, the sole EBDC recommendation is for brown rot; recommended alternatives are benomyl, bordeaux mixture, captan, fixed copper, and sodium pentachlorophenate. Washington, which produces about 2% of the U.S. apricot crop, recommends maneb for leaf curl and coryneum blight.

Brown rot is a serious disease problem which attacks both the blossoms and fruit of apricots and other stone fruits. No fungicide use survey data is available for apricots to indicate EBDC use for control of brown rot and other diseases. California pesticide use data (Table I-8) shows that total EBDC use on apricots has been quite minimal, ranging from 5 acres treated in 1976 to 1,625 acres treated in 1970; 433 acres were treated with EBDC's in 1977. However, these data probably understate actual EBDC use on apricots in California since these materials are not among the pesticide classes whose use is required to be reported. The California rebuttal to the EBDC RPAR indicates that actual use of EBDCs in the state is probably twice the reported level. Thus, EBDC use on apricots in 1978 may reasonably be estimated at a maximum of about 900 acres. This indicates that about 3% of California's 30,000 acres of apricots could be treated with EBDCs annually.

As noted in the California rebuttal, maneb is probably used in combination or in rotation with benomyl to check the development of benomyl-resistant strains of fungus on apricots.

If the EBDC fungicides (principally maneb) are unavailable for use on apricots, growers will likely utilize benomyl or captan for the sprays in which maneb had been used alone. For those instances in which maneb had been used in combination with benomyl, captan is likely to be substituted. The utilization of EBDC alternatives would change per-acre treatment costs from $10.50 with maneb to $16.50 (benomyl) or $7.50 (captan) (Table I-9). Total worst-case cost impacts for the 900 acres of apricots treated with EBDCs in 19/8 (maximum) would consist of an increase of about $3,600 annually. Since the use of alternatives is not expected to increase revenues due to higher fruit yield or quality, any pesticide cost increases would represent net reductions in overall revenues for affected growers.

Although the immediate cost impacts associated with the unavailability of EBDCs for use on apricots are relatively minor, the economic implications of the cancellation of EBDCs extend beyond the costs of alternatives. The major benefit derived from the use of EBDCs on apricots concerns the avoidance or minimization of the continuing problem of fungal resistance to first-choice fungicides, particularly benomyl. EBDCs are probably used by growers experiencing difficulty in controlling diseases with other materials and/or by growers using a multi-fungicide rotation program to avoid resistance. Benomyl, the first-choice fungicide for several diseases attacking apricots and other fruits, is susceptible to resistance buildup within a few years after its first use if applied frequently. In California, widespread reliance on benomyl during the past several years is reported

to have caused severe control problems, particularly in peach orchards. Fungal resistance to benomyl is considered a likelihood, if not a certainty, on all fruit crops if it is used exclusively or predominantly. Although growers would not be expected to rely solely upon EBDCs if benomyl resistance becomes widespread in apricots, the EBDCs would be major alternatives, particularly in view of the RPAR status of other materials such as captan.

TABLE I-6

EPA REGISTRATIONS OF EBDC's AND ALTERNATIVES FOR CONTROL OF APRICOT DISEASES[1/]

Fungicide	Diseases: Brown rot	Coryneum Blight (shothole)	Jacket rot (Green rot)	Leaf curl	Shothole
Maneb	M	M,Z	M		M
Nabam				N,Z	
Zineb		M,Z		N,Z	M
Benomyl	M				
Calcium Oxychloride				N	
Captafol	M	M,Z		N,Z	M
Captan	M		M		
Copper Bordeaux Mixture	M		M		
Copper Carbonate	M	M,Z			M
Copper Oleate		M,Z			M
Copper Oxide	M	M,Z			M
Copper Oxychloride Sulfate	M	M,Z		N,Z	M
Copper, Sulfate, Basic		M,Z			M
Copper Tetra Copper Calcium Oxychloride	M	M,Z		N,Z	M
Ferbam		M,Z	M		M
Ziram		M,Z			M

1/ M = Registered uses of maneb and alternatives; N = Registered uses of nabam and alternatives; Z = Registered uses of zineb and alternatives.

Source: (39)

Fungicide	Bacterial spot	Brown rot-blossom & fruit	Cytospora canker	Fusicoccum canker	Leaf curl	Mildew	Disease Peach (coryneum) blight	Phytophthora fruit rot	Powdery mildew	Rhizopus rot	Rust	Scab	Sooty mold	Shot-hole
Maneb	--	CA	--	--	WA	--	WA	--	--	--	--	--	--	--
Zineb	OH	MD	--	--	--	--	--	WA(P)	--	--	--	MD	--	--
Benomyl	PA(P&N)	AL,CA,GA KY,MD,NJ, NC,OH,OR, PA,SC,TX, VA,WV	NY	--	--	--	--	--	MI(P&N), NJ	AL,NC	--	AL,GA, KY,MI, NJ,NC, OH,PA, SC,TX, VA,WV	PA(P&N)	--
Bordeaux 2/	OH	CA	--	--	CA(P&N), KY,MD, MI(P&N),OH, PA(P),VA, WA,WV	--	CA(P&N),WA	--	--	--		--	--	--
Calcium polysulfide (lime sulfur)	--	MI(P&N),OH	--	--	AL,GA,KY, MD,MI(P&N), NC,OH,SC, VA,WA(P&N), WV	--	WA(P&N)	--	CA(P&N)	--	CA(P&N)	--	--	--
Captan 3/	GA,MD, MI(P&N), PA(P&N), SC	AL,CA,GA, KY,MD,MI, NJ,NC,OH, OR,PA,SC, TX,VA,WA, WV	--	--	--	MD	CA(P&N), WA	--	NJ	AL,GA, KY,NC, SC,TX, VA	--	AL,GA, KY,MD, MI,NY, NC,PA, SC,TX, VA,WV	PA (P&N)	CA(A)
Copper 4/	TX	CA	--	NJ	CA(P&N), OR,TX,WA	--	CA(P&N), OR,WA	--	--	--	--	--	--	--
Dichlone	PA(P)	CA(P),KY, MD,MI(P&N), NJ,OH,PA(P), WA(P)	--	--	MD	--	CA(P),WA(P)	--	NJ	--	--	--	--	--
Dichloran	--	CA(P&N),MD, SC,TX,VA	--	--	--	--	--	--	--	GA,KY, NC,SC, TX,VA	--	--	--	--
Dinocap	--	--	--	--	--	CA(A)	--	--	NJ	--	--	--	--	--
Dodine 3/	GA,MD, MI(P&N), SC	MI(P&N)	--	--	--	--	--	--	--	--	--	--	--	--
Ferbam	--	--	--	--	AL,CA(P&N), GA,KY,MD, NJ,NC,OH, PA(P)	--	CA(P&N), SC,VA(P), WA,WV	--	--	--	CA(P&N)	--	--	--
Sulfur 5/	PA(P&N)	AL,CA(P&N), GA,KY,MD, MI(P&N),NJ, NC,OH,OR,PA, SC,TX,VA, WA(P&N),WV	--	--	--	MD,OR	OR	--	CA(P&N), MI(P&N), NJ,WA(P&N)	NC	CA, (P&N), TX	AL,GA, KY,MD, MI(P&N), NJ,NC,OH, PA,SC,TX, WV	PA(N)	--
lium tachoro- mate	--	CA(A)	--	--	--	--	--	--	--	--	--	--	--	--
ram	--	OH	--	--	--	--	--	--	--	--	--	--	--	--
c, ic fate	GA,MD	--	--	--	--	--	--	--	--	--	--	--	--	--
am	--	OR	--	--	CA(P),WA	--	CA(P)	--	--	--	--	--	--	CA(A)

1/ This table summarizes the most recent available recommendations from the following states: Alabama (AL), California (A), Georgia (GA), Kentucky (KY), Maryland (MD), Michigan(MI), New Jersey (NJ), North Carolina (NC), Ohio (OH), Oregon (OR), Pennsylvania (PA), South Carolina (SC), Texas (TX), Virginia (VA), Washington (WA), and West Virginia (WV). The following state recommendations include only peaches: AL, GA, MD, NJ, NC, OH, OR, SC, TX. The following recommendations include peach and nectarine: KY, VA, WV. The following recommendations include peach, nectarine, and apricot: CA, MI, PA, WA. The MD recommendations also include disease controls for interplanted peaches and apples. Unless indicated otherwise, the recommendations are for all fruits in the control guide or schedule; if a fungicide is recommended only for use on a particular crop, the state abbreviation is followed by those crops on which the use of the chemical in question is recommended (P = peach, N = nectarine, A = apricots).

2/ The Ohio recommendations guide (page 33) indicates that copper sulfate and lime (Bordeaux ingredients) should be applied separately for effective bacterial spot control.

3/ The Michigan recommendation guide indicates that the use of a captan + dodine combination for bacterial spot and/or brown rot at petal fall is to be on a trial basis for susceptible varieties.

4/ All "copper" recommendations are "fixed copper" except the following: TX- copper hydroxide; MI - copper sulfate + lime + lead arsenate + superior oil.

5/ Various formulations are included in this single table heading.

Sources: [illegible]

REPORTED USE OF EBDC FUNGICIDES ON DECIDUOUS FRUITS AND NUTS IN CALIFORNIA, 1970-1977[1/]

Year	Fungicide[2/]	Almond acres treated	Almond quantity applied	Apricot acres treated	Apricot quantity applied	Cherry acres treated	Cherry quantity applied	Nectarine acres treated	Nectarine quantity applied	Peach acres treated	Peach quantity applied	Walnut acres treated	Walnut quanity applied
1970	maneb	5,069	26,981	1,017	2,965	- -	- -	467	3,384	3,086	37,450	3	19
	nabam	1,215	3,879	573	3,105	2	8	857	3,568	3,339	13,183	- -	- -
	zineb	142	65	35	38	- -	- -	325	238	1,498	1,384	- -	- -
1971	maneb	2,097	12,461	53	262	- -	- -	- -	- -	376	1,071	12	38
	nabam	35	142	- -	- -	- -	- -	38	181	416	1,498	- -	- -
	zineb	- -	- -	122	201	- -	- -	42	10	29	172	- -	- -
1972	maneb	2,157	9,928	49	218	14	28	55	273	212	1,182	- -	- -
	nabam	124	983	- -	- -	- -	- -	76	480	320	3,572	- -	- -
	zineb	- -	- -	2	6	- -	- -	827	5,604	2,162	9,476	- -	- -
1973	maneb	3,747	21,578	368	1,998	- -	- -	151	670	723	4,025	51	17
	nabam	- -	- -	- -	- -	- -	- -	281	1,146	180	1,153	- -	- -
	zineb	87	497	30	158	- -	- -	953	4,814	2,379	12,941	- -	- -
1974	maneb	3,662	23,147	31	178	- -	- -	22	107	252	1,196	- -	
	zineb	- -	- -	11	25	- -	- -	- -	- -	1,409	7,014	- -	- -
1975	maneb	3,838	21,107	188	1,203	- -	- -	21	121	179	592	- -	- -
1976	dithane	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
	maneb	1,997	14,166	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
	zineb	- -	- -	5	27	- -	- -	- -	- -	747	2,784	- -	- -
1977	dithane	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
	maneb	1,952	10,986	429	1,664	- -	- -	109	546	1,339	6,695	- -	- -
	zineb	- -	- -	4	18	- -	- -	- -	- -	62	221	- -	- -

1/ Does not include apples, pears, plums, or prunes.
2/ Formulation(s) of dithane reported used in 1976 and 1977 was not specified.

Sources: (5, 6, 7, 8, 9, 10, 11, 12)

Table I-9

Comparative Costs of Treatment with Maneb and Alternatives for Apricot Disease Control

fungicide	product cost1/	application rate/acre2/	material cost per acre-treatment
maneb 80 W	$ 1.75/lb.	6 lbs.	$10.50
benomyl 50 WP	$11.00/lb.	1.5 lbs.	$16.50
captan 50 W	$1.25/lb.	6 lbs.	$ 7.50

1/ Average material costs based on review of various pesticide price lists.
2/ As specified in the California apricot pest control guide, assuming 300 gallons of spray per acre. (15).

Bananas

Two EBDC fungicides--mancozeb and maneb--are EPA registered for use on bananas to control Sigatoka disease. Registered alternatives include benomyl, copper hydroxide, copper oxide, copper Bordeaux mixture, petroleum oil, and thiophanate methyl. Since bananas are not produced commercially in the United States, the analysis is not concerned with grower level impacts but deals with the consumer impacts of the revocation of EBDC tolerances on bananas produced in other countries[1/]. Although bananas are produced in many tropical and subtropical areas of the world, U.S. imports are derived primarily from a few Central and South American countries, including Columbia, Costa Rica, Ecuador, Guatemala, Honduras, Nicaragua, and Panama. Average annual banana imports into the U.S. approximate 2,029,000 metric tons (Table I-10). Per capita banana consumption was 19.5 pounds in 1977, and appears to have trended upward since 1970 (Table I-11).

Maneb was the first EBDC introduced for use on bananas but was quickly replaced by mancozeb due to increased efficacy. Since Sigatoka is present in all banana producing areas, it is probably reasonable to include that all bananas imported into the U.S. have been treated with mancozeb, which is used in disease spray programs along with benomyl and petroleum oil. Mancozeb and benomyl are each blended in oil or in an oil plus water emulsion and applied by air. In general, two mancozeb treatments are followed by one benomyl treatment. The total number of sprays varies from 12 to 30 and

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1/ Small quantities of bananas are produced in Hawaii. During the period 1975-1977, an average of 5.7 million pounds were produced valued at $847,000 annually. All bananas produced in Hawaii are consumed fresh, probably within the State. No data are available indicating the extent or importance of EBDC use (if any) on bananas in Hawaii.

averages about 18 per year; thus, the mancozeb-benomyl cycle is usually repeated about six times per season. Mancozeb 80 WP is applied at the rate of 1.5 pounds formulation per acre-treatment. Assuming an average of 12 treatments per year indicates annual use of 18 pounds mancozeb 80 WP (14.4 pounds a.i.) per acre.

If the EBDC tolerances for bananas are revoked as the result of an Agency regulatory action, the net effect would be cancellation of EBDC use on bananas produced for export to the United States. Growers in the affected countries would have the option of producing for export to other countries (assuming other importing nations did not follow EPA's lead in revoking EBDC tolerances, which is probably unlikely) or adopting other disease control materials. If many growers adopted the former approach, the Japan-Europe banana market would be flooded and prices would probably drop to extermely low levels. Growers adopting a non-EBDC spray schedule in order to maintain U.S. sales would encounter disease control problems.

The use of a non-EBDC disease control program in Central and South America would lead to greater reliance on benomyl, thiophanate methyl, and petroleum oils. (Both benomyl and thiopanate methyl are also being reviewed in RPAR proceedings.) Yields would remain constant in the short term in all countries except for Honduras. In Honduras, the presence of Black Sigatoka (a disease similar to Sigatoka) would necessitate the use of copper-based fungicides in addition to benomyl, thiophanate methyl, and oil. The phytotoxic properties of copper compounds when used in spray programs involving oil (necessary because oil must be used with the benzimadozotes for them to be effective) would lead to yield losses estimated to be in the range of 10 to 20 percent. In the longer term, the combined effect of (1) the expected

spread of Black Sigatoka due to the reduced effectiveness of non-EBDC spray programs, and (2) the reduced effectiveness of benomyl due to anticipated resistance problems may cause yield reductions of 10 to 20 percent in all those countries now producing bananas for export to the U.S.

U.S. consumers would be adversely affected due to retail price increases if the EBDC banana tolerances are revoked. The extent of such price effects would depend on numerous factors, including (1) the rate and severity of spread of Black Sigatoka, (2) the development of resistance or tolerance to benomyl, (3) the extent to which bananas now sold to European and Japanese markets would be diverted to the U.S., and (4) the possibility of increased banana production in all other banana-producing areas in response to higher prices in the U.S. market.

Assuming the eventual spread of Black Sigatoka, development of benomyl resistance, and lack of re-orientation of the current Japan-Europe market producers, U.S. imports could decline in the longer term by 10 to 20 percent. Use of the mid-point value (-0.75) of the most recently developed (1971) retail price elasticity of demand estimates for bananas indicates that U.S. retail banana prices could increase by 13.3 percent for every 10 percent reduction in supply. Thus, yield reductions of 10 to 20 percent could lead to retail price increases ranging from 13.3 to 26.6 percent. These loss estimates indicate the retail price of bananas could increase from 23.2 cents per pound (1975) to 26.3 - 29.4 cents per pound, depending upon the extent of yield reduction (10 to 20 percent) and the price elasticity of demand estimate used (in this case, -0.75). The average U.S. consumers expenditures for bananas would increase from $4.52 per year (23.2¢ lb. x 19.5 lbs) to $4.59 0 $4.66 per year (26.3¢ x 17.55 lbs. = $4.62 or 29.4¢ x 15.6 lbs = $4.59). Total U.S. consumer expenditures for banans would increase from $972 million per year to $989 million - $993 million per year, again depen-

dent upon the yield losses sustained and the price elasticity of demand estimate used to calculate retail price effects (assumes 215,000,000 U.S. population).

The consumer impacts projected in this analysis are subject to several important limitations. The primary limitation concerns the inconsistency of data concerning the price response resulting from the projected declines in banana supplies. The price changes developed herein are based on a single price elasticity value which may or may not be representative for current and future situations, since elasticities respond over time to changes in market conditions. General economic price theory indicates that over time the price elasticity of demand at the retail level would move closer to unity in response to a decline in banana supplies, ceteris paribus. Thus, the projected increases in expenditures at the retail level cannot be expected to continue idenfinitely. Increasingly larger reductions in banana supplies would lead to the point where the elastic portion of the demand schedule would be reached and reductions in overall expendiuters would result.

It is likely that the reductions in production projected in this analysis would lead to significantly higher retail prices for bananas in the U.S. However, specific retail price responses cannot be accurately determined given currently available price elasticity of demand data (available elasticity values represent point estimates and would not be reliable over the range of projected quanity changes). Thus, the price increases presented above cannot be relied upon with great certainty. It is reasonable to conclude however, that a revocation of EBDC tolerances on imported bananas would lead to some degree of retail price increase.

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Table I-10 - U.S. fresh banana imports by country of origin, calendar years, 1974-77

Country	1974	1975	1976	1977
		1,000 metric tons		
Colombia	108.4	142.1	111.3	105.5
Costa Rica	385.7	631.0	695.6	556.0
Ecuador	476.7	430.7	396.3	441.3
Guatemala	236.5	204.6	234.3	214.7
Honduras	536.7	262.6	485.4	512.1
Nicaragua	106.3	121.2	111.1	104.1
Panama	126.2	108.6	57.1	142.7
Other	9.7	9.6	11.9	40.4
Total	1,986.2	1,910.4	2,103.0	2,116.8

Source: Bureau of the Census, U.S. Department of Commerce.

TABLE I-11 Fresh fruit: Per capita consumption, fresh weight basis, average 1950-54 and 1955-59, annual 1960-77[1]

Year	Citrus fruit							Noncitrus fruit					
	Oranges	Tangerines	Tangelos	Lemons	Limes	Grapefruit	Total citrus	Apples	Apricots	Avocados	Bananas	Bushberries[3]	Cherries
	Pounds												
1950-54 av.	27.1	2.1	---	3.8	0.15	10.5	43.7	22.2	0.4	0.5	20.1	---	0.7
1955-59 av.	21.3	1.7	[2]0.14	3.1	.14	10.2	36.6	20.3	.3	.6	17.8	---	.5
1960	19.3	1.2	.2	2.9	.12	10.0	33.7	18.3	.21	.9	20.5	---	.4
1961	16.1	1.8	.2	2.8	.12	9.8	30.8	16.4	.20	.4	19.9	---	.5
1962	15.6	1.5	.4	2.8	.11	9.1	29.5	17.5	.20	.6	16.3	---	.5
1963	11.9	.9	.3	2.5	.13	6.4	22.1	16.7	.16	.5	16.6	---	.4
1964	14.3	1.4	.3	2.6	.12	7.5	26.2	17.9	.20	.6	16.9	---	.6
1965	16.4	1.6	.4	2.4	.14	8.3	29.2	16.3	.10	.4	17.9	---	.4
1966	16.4	1.6	.4	2.3	.12	8.4	29.2	16.0	.17	.6	18.3	---	.5
1967	17.9	1.9	.6	2.3	.10	9.0	31.8	16.2	.11	.8	18.3	---	.5
1968	14.1	1.3	.6	2.2	.15	8.0	26.4	15.7	.11	.5	18.5	---	.5
1969	16.1	1.6	.6	2.1	.15	7.8	28.4	14.9	.09	.7	18.0	---	.5
1970	16.2	1.6	.6	2.0	.19	8.2	28.8	18.3	.12	.4	17.6	.18	.5
1971	15.8	1.8	.7	2.2	.19	8.6	29.3	16.2	.14	.8	18.3	.16	.6
1972	14.5	1.7	.7	1.9	.22	8.6	27.6	17.4	.08	.4	18.1	.11	.3
1973	14.5	1.7	.6	2.0	.22	8.6	27.6	14.7	.09	.8	18.4	.15	.7
1974	14.6	1.9	.7	2.0	.23	8.3	27.7	16.1	.06	.7	18.7	.16	.6
1975	16.1	2.0	1.0	2.0	.24	8.4	29.7	17.9	.08	1.2	17.9	.16	.7
1976	14.9	2.0	.9	1.9	.26	9.4	29.4	18.8	.10	.8	19.5	.11	.8
1977[5]	13.0	1.8	1.0	2.1	.26	7.8	26.0	18.5	.09	1.3	19.5	.06	.6

Year	Noncitrus fruit (continued)												
	Cranberries	Figs	Grapes	Nectarines	Peaches	Pears	Pineapple	Papayas	Plums and prunes	Strawberries	Miscellaneous fruit[4]	Total noncitrus	Total fruit
	Pounds												
1950-54 av.	0.3	0.04	5.4	0.2	9.7	4.0	0.5	---	1.8	1.5	---	67.4	111.1
1955-59 av.	.3	.03	4.3	.3	8.8	3.5	.6	---	1.6	1.5	---	60.3	96.9
1960	.24	.02	3.9	.5	9.5	2.6	.6	.06	1.2	1.3	---	60.2	93.9
1961	.29	.02	3.8	.6	9.7	2.6	.5	.08	1.3	1.6	---	57.9	88.7
1962	.28	.02	4.2	.5	8.2	2.6	.4	.07	1.3	1.6	---	54.3	83.8
1963	.22	.02	4.2	.6	7.6	2.0	.5	.06	1.4	1.6	---	52.6	74.7
1964	.22	.02	3.9	.7	6.0	2.4	.6	.09	1.5	1.7	---	53.3	79.5
1965	.19	.02	4.2	.7	6.8	1.8	.6	.08	1.4	1.3	---	52.2	81.4
1966	.17	.02	4.3	.7	6.2	2.4	.5	.08	1.2	1.4	---	52.6	81.8
1967	.14	.01	3.5	.5	4.9	1.8	.6	.10	1.3	1.5	---	50.2	82.0
1968	.15	.02	3.8	.6	6.6	2.0	.6	.10	1.3	1.8	---	52.2	78.6
1969	.17	.01	3.6	.6	6.7	2.2	.6	.08	1.1	1.8	---	51.1	79.5
1970	.18	.01	2.8	.6	5.7	2.0	.7	.12	1.5	1.8	.14	52.6	81.4
1971	.20	.01	2.4	.6	5.7	2.4	.7	.10	1.3	1.9	.16	51.7	81.0
1972	.15	.03	2.2	.8	3.9	2.5	.8	.11	1.1	1.7	.15	49.9	77.5
1973	.19	.04	2.6	.7	4.3	2.5	.9	.14	1.2	1.6	.18	49.2	76.8
1974	.15	.05	2.8	.9	4.4	2.3	.9	.17	1.5	1.9	.20	51.7	79.4
1975	.15	.03	3.2	.9	5.1	2.8	1.0	.17	1.3	1.8	.24	54.7	84.4
1976	.19	.02	3.3	1.0	5.3	2.7	1.2	.21	1.3	1.7	.23	57.2	86.6
1977[5]	.18	.03	3.1	1.2	5.4	2.7	1.3	.26	1.6	2.0	.17	58.1	84.1

[1] All data on calendar-year basis with exception of citrus fruits, which start October or November prior to year indicated. Civilian consumption only. Beginning 1960, includes Alaska and Hawaii. [2] Three-year average. [3] Includes blackberries, blueberries, boysonberries, currants, loganberries, black and red raspberries, and other berries. [4] Includes mangoes, olives, persimmons, pomegranates, chinese gooseberries, and other fruit. [5] Preliminary.

Note: See September 1970 (TFS-176) *Fruit Situation* for annual data prior to 1960.

SOURCE: (37A).

Cherries

Two EBDC fungicides are EPA registered for control of cherry diseases. Nabam and zineb are both registered for leaf spot and shot hole. Numerous alternatives are available for leaf spot but only one non-EBDC alternative (basic copper sulfate) is registerd for shot hole (Table I-12).

A review of state pesticide recommendations indicates that, of the control guides examined, none included EBDCs among the fungicides listed for control of cherry diseases (Table I-13). Based on the number of states recommending materials for control, the preferred fungicides for leaf spot include benomyl, captan, dodine, ferbam, and folpet. Washington is the only state listing shot hole, and recommends captan, lime sulfur, copper, and dichlone for control.

The EBDCs are not used to an appreciable extent on cherries. Fungicide use data indicates no use of EBDCs on cherries in 1975 (Table I-14). Review of 1975 proprietary data also shows no use of EBDC fungicides on domestic cherries. California usage data (Table I-8) shows very little use of EBDC fungicides on cherries in recent years.

The lack of recommendations for or use of EBDC fungicides to control diseases of cherries indicates that these particular materials are not important to the production of this crop. The economic impact resulting from the cancellation of EBDC registration for cerries would be negligible.

TABLE I-12

EPA REGISTRATIONS OF EBDC's AND ALTERNATIVES FOR CONTROL OF CHERRY DISEASES[1/]

Fungicide	Disease: Leaf spot	Disease: Shothole
Nabam[2/]	N	N
Zineb	Z	Z
Benomyl	N,Z	
Captafol[2/]	N,Z	
Captan	N,Z	
Copper carbonate	N,Z	
Copper sulfate, basic		N,Z
Dichlone	N,Z	
Dodine	N,Z	
Ferbam	N,Z	
Folpet	N,Z	
Sulfur	N,Z	

1/ N = Registered uses of Nabam and alternatives; Z = Registered uses of Zineb and alternatives.
2/ Registered for use on sour cherries only.

Source: (39)

Table I-13

Summary of State Recommendations for Control of Cherry Diseases 1/

r	Black knot 7/	Disease Botrytis rot	Brown and blight	Coryneum rot (shothole)	Fruit blight	Leaf spot rot	Mildew	Powdery mildew	Rhizopus rot
	WV	NJ,NY	CA,KY,MI, NJ,NY,OH, PA,VA,WV	—	—	KY,MI,NJ,NY OH,PA,VA,WV	WV	MI(T),NY(T), PA(T),VA,WV	MI(S)
	—	—	CA,MI(S)	—	—	CA,VA	—	—	—
	—	—	—	WA	—	—		CA	—
	—	NY(T)	CA,MI(T), NY(T),	—	PA(T)	MI(T),NY(T), PA(T)	—	PA(T)	— —
	WV	NJ,NY	CA,MI(S), NJ,NY, OH(S)PA, VA,WV	WA	PA(T)	MI(S),NJ,NY, OH(S),Pa,VA,WV	WV	PA(T),WV	MI(S)
	—	—	CA,KY, OH(T)	WA	—	KY,NY(T),OH(T), PA(T)	—	NY(T),PA(T)	—
	WV	NJ,NY	CA,KY,MI, NJ,NY,OH, PA,WV	WA	—	NJ,OH(S),PA	—	—	—
	—	—	CA	—	—	—	—	—	CA
	—	—	KY,MI(T), OH(T)	—	—	KY,MI,NJ,NY, H,PA(S),VA,WV	—	—	—
	WV	NY	MI,NY,OH, PA(S)	—	—	MI(S),NY,OH(S), PA(S),VA,WV	WV	WV	MI(S)
	WV(T)	NY(T)	NY(T), PA(T),	—	PA(T)	NY(T),PA(T), VA,WV(T)	WV(T)	PA(T)	—
	—	—	NJ	—	—	NJ,NY	—	—	—
	WV	NY(S)	CA,KY,MI, NY,OH(T), PA(S),WA	—	—	MI,NY,PA, WV	WV	CA,NY(T),VA, WA,WV	MI(S)

recent available recommendations from the following states: California (CA), Kentucky (KY), Michigan (MI),
, Ohio (OH), Pennsylvania (PA), Virginia (VA), Washington (WA), and West Virginia (WV). Unless indicated
include both sweet and tart cherries; if a particular fungicide is recommended only for use on sweet or
viation is followed by an indicator for the cherry type on which the fungicide is recommended (S = sweet
ommendations included are for control of preharvest tree and fruit and postharvest tree diseases.

de fixed copper, fixed copper plus hydrated lime, and copper sulfate plus lime.

rvest use only.

ons indicate that ferbam should be used on tart cherries when dodine (MI and OH) or glyodin (OH) are used with

ination for leaf spot on tart cherries in New York.

der.

ide (p. 21) reads: "There are no fungicides approved for 'black knot' control on plums and prunes, or cherries.
spray program for brown rot control is followed, black knot usually will not be a problem."

43, 45, 46, 47).

TABLE I-14 EXPENDITURES, TOTAL TREATMENT ACRES, GROWERS TREATING, AND AVERAGE NUMBER OF APPLICATIONS BY TYPE OF CHEMICAL APPLIED, AS ESTIMATED FOR 1975.

CROP: Cherries
PRODUCT: Fungicides
AREA: Total U.S.

Type of Chemical	Expenditures Dollars (000)	Expenditures Pct.	Total Treatments[1] Acres (000)	Total Treatments[1] Pct.	Growers Treating Growers	Growers Treating Pct.	Avg. No. of Applications
Benlate	1269	48.3	159	34.8	3057	15.1	3.5
Bordeaux	27	1.0	2	0.4	233	3.4	2.0
Captan	31	1.2	14	3.1	772	11.4	3.0
Copper Sulfate	27	1.0	5	1.1	424	6.3	1.3
Cyprex	283	10.8	64	14.0	1098	16.2	4.5
Dichlone	48	1.8	11	2.4	248	3.7	2.2
Difolatan	274	10.4	77	16.8	961	14.2	3.3
Ferbam	41	1.6	6	1.3	233	3.4	3.5
Kocide	14	0.5	2	0.4	154	2.3	1.0
Lime Sulfur	9	0.3	5	1.1	145	2.1	2.5
Sulfur	110	4.2	40	8.8	1075	15.9	2.4
Cyprex/Sulfur	90	3.4	11	2.4	218	3.2	2.2
Dichlone/Sulfur	17	0.7	3	0.7	135	2.0	3.0
Ferbam/Sulfur	17	0.7	5	1.1	218	3.2	2.5
Other Misc. Chemicals	82	3.1	22	4.8	568	8.4	4.0
Other Misc. Combinations	284	10.8	30	6.6	913	13.5	3.8
Unidentified	4	0.2	1	0.2	57	0.8	1.0
Subtotal	2627	100.0	457	100.0	6773	*.*	*.*
No Answer	2				35		
Total	2629		457		6808		

1) Includes Multiple Applications.

Source: (22).

Nectarines and Peaches

Three of the EBDC fungicides - i.e., maneb, nabam, and zineb - are registered for use on nectarines and peaches. Diseases for which these materials are registered include brown rot, coryneum blight (shothole), leaf curl, leaf spot, and scab (Tables I-15 and I-16). Numerous other fungicides are registered for brown rot, shothole, and leaf curl, but relatively few EBDC alternatives exist for leaf spot and scab, particularly for nectarines.

California produces almost all (98+%) domestic nectarines and is the major peach state (70% of U.S. crop). The sole EBDC recommended for use on nectarines and peaches in California is maneb. California also recommends numerous alternative fungicides for brown rot control (Table I-7). Three other peach-producing states recommend maneb and zineb for various other diseases of nectarines and peaches.

No national fungicide usage data is available to determine the extent of EBDC use on nectarines. However, California pesticide use data (Table I-8) indicate reported use of EBDCs on nectarines in recent years has ranged from 7,190 pounds active ingredient applied to 1,649 acres (1970) to 107 pounds a.i. applied to 22 acres (1974); 546 pounds a.i. were reported applied to 109 acres in 1977. As indicated in Section 1 (Apricots), California authorities estimate that actual EBDC use is probably twice the reported level; thus, 1978 usage (all EBDCs, most likely maneb) probably approximates as much as 1,100 pounds a.i. applied to about 220 acres of nectarines. Thus, about 1% of California's 20,000 nectarines acres would be treated with EBDCs annually. Since almost all U.S. nectarine production takes place in California, the extent of use estimates represent total domestic EBDC use on this particular crop.

Fungicide usage data for peaches show that the EBDCs are not used to an appreciable extent. Review of 1975 usage data (Table I-17) indicates no reported use of EBDCs on peaches. California pesticide use data (Table I-8) show the reported use of EBDCs on peaches has ranged from 52,017 pounds a.i., applied to 7,923 acres (1970) to 593 pounds a.i. applied to 179 acres (1975). In 1977, a reported 6,695 pounds a.i. were applied to 1,339 acres. Since reported use in California may understate actual use by half, as many as 13,500 pounds a.i. may have been applied to about 2,700 acres of peaches in the state in 1978. Since California has about 88,000 acres of peaches, about 3% of the state's crop may be treated with EBDCs for disease control. Small amounts of EBDCs are probably used on peaches in other states, but these quantities are not significant enough to be reflected in pesticide use surveys.

The EBDCs, particularly maneb, are probably most widely used in combination with benomyl or as a rotation treatment instead of benomyl for control of brown rot. Zineb may also be used in this pattern as an alternative for maneb, probably depending upon the relative prices of the two materials. The major alternatives to the EBDCs on nectarines and peaches are dichloran and captan. If these materials are used on nectarines and peaches instead of maneb, per acre treatment costs change from $10.50 (maneb) to $14.00 (dichloran) or $7.50 (captan) (Table I-18). Assuming the 1978 EBDC use level in California approximates the estimated use level of 2,700 peach acres and 220 nectarine acres treated, the loss of EBDCs and utilization of alternatives could increase control costs by a maximum of about $10,000 annually. Similar per acre costs effects would be expected to occur in other EBDC use areas. The cost effects would be absorbed at the grower level. No immediate consumer effects are anticipated.

As in the case of apricots, the cancellation of EBDCs for use on nectarines and peaches has implications beyond the relatively small cost impacts associated with the use of alternatives. The demonstrated problem of fungal tolerance or resistance to benomyl, the preferred fungicide for brown rot and other nectarine and peach diseases, is almost certain to result in increased grower dependence on the EBDC fungicides. Materials such as maneb and zineb would not be the only materials having increased use if benomyl is ineffective, but they would probably be among the few major substitutes.

TABLE I-15

EPA REGISTRATIONS OF EBDC's AND ALTERNATIVES FOR CONTROL OF NECTARINE DISEASE[1/]

Fungicide	Brown rot	Coryneum blight (shothole)	leaf curl	leaf spot	scab
	Diseases				
Maneb	M,Z	M, Z			
Nabam			N		
Zineb	M,Z	M, Z	Z	Z	Z
Benomyl	M,Z				Z
Calcium Hypochlorite			Z		
Calcium Polysulfides	M,Z	M, Z	N	Z	
Captafol		M, Z	N,Z		
Captan	M,Z	M, Z			Z
Copper Bordeaux Mixture	M,Z	M, Z	N,Z		
Copper Carbonate	M,Z	M, Z	N,Z		
Copper Chloride			N		
Copper Napthenate			N,Z		
Copper Oleate		M, Z			
Copper Oxychloride	M,Z	M, Z	N,Z		
Copper Oxychloride sulfate	M,Z	M, Z	N,Z		
Copper Sulfate, Basic		M, Z	N,Z		
Copper Sulfate Monohydrates	M,Z				
Dichloran	M,Z				
Ferbam	M,Z				Z
Sulfur	M,Z	M, Z		Z	
Ziram	M,Z	M, Z	Z		

1/ M = Registered uses of maneb and alternatives; N = Registered uses of nabam and alternatives: Z = Registered uses of zineb and alternatives.

Source: (39).

TABLE I-16

EPA REGISTRATIONS OF EBDC's AND ALTERNATIVES FOR CONTROL OF PEACH DISEASES1/

Fungicide	Brown rot	Coryneum blight (shothole)	Leaf curl	Leaf Spot	Scab
Maneb	M,Z	M,Z	N	Z	M
Nabam			N		
Zineb	M,Z	M,Z		Z	M
Benomyl	M,Z				M
Calcium polysulfides	M,Z	M,Z	N	Z	M
Captafol	M,Z	M,Z	N	Z	M
Captan	M,Z	M,Z		Z	M
Copper Bordeaux mixture	M,Z	M,Z	N		
Copper carbonate	M,Z	M,Z	N		
Copper hydroxide			N		
Copper napthenate			N		
Copper oleate		M,Z			
Copper oxide		M,Z	N		
Copper oxychloride	M,Z	M,Z	N		
Coppe oxychloride sulfate	M,Z	M,Z	N		
Copper sulfate, basic		M,Z	N		
Copper sulfate, monohydrate	M,Z	M,Z	N		
Copper tetra copper calcium oxychloride		M,Z	N		
Dichlone	M,Z	M,Z	N		
Dichloran	M,Z				
Dodine			N		
Ferbam	M,Z	M,Z	N		
Glyodin	M,Z				
Sodium polysulfides	M,Z	M,Z	N		
Sulfur	M,Z	M,Z		Z	M
Thiram	M,Z			Z	M
Ziram	M,Z	M,Z	N		

1/ M = Registered use of Maneb and alternatives; N = Registered use of nabam and alternatives; Z = Registered use of zineb and alternatives

Source: (39)

TABLE I-17 EXPENDITURES, TOTAL TREATMENT ACRES, GROWERS TREATING, AND AVERAGE NUMBER OF APPLICATIONS BY TYPE OF CHEMICAL APPLIED, AS ESTIMATED FOR 1975.

CROP: Peaches
PRODUCT: Fungicides
AREA: Total U.S.

Type of Chemical	Expenditures Dollars (000)	Expenditures Pct.	Total Treatments[1] Acres (000)	Total Treatments[1] Pct.	Growers Treating Growers	Growers Treating Pct.	Avg. No. of Applications
Benlate	1877	44.5	326	25.4	13455	56.7	2.6
Ferbam	46	1.1	13	1.0	899	3.8	1.6
Sulfur	797	18.9	540	42.1	11522	48.6	5.3
Cyprex	60	1.4	17	1.3	536	2.3	5.0
Captan	387	9.2	180	14.1	7187	30.3	3.9
C-O-C-S	19	0.5	5	0.4	180	0.8	1.0
Copper Sulfate	199	4.7	27	2.1	1150	4.9	1.0
Dichlone	28	0.7	8	0.6	1072	4.5	1.8
Kocide	14	0.3	3	0.2	238	1.0	1.5
Lime Sulfur	15	0.4	9	0.7	485	2.1	1.6
Oil	8	0.2	4	0.3	154	0.7	1.0
Tri-Basic	103	2.4	4	0.3	276	1.2	1.0
Ziram	17	0.4	6	0.5	244	1.0	1.0
Benlate/Sulfur	73	1.7	18	1.4	363	1.5	4.8
C-O-C-S/Oil	56	1.3	8	0.6	180	0.8	1.0
Copper Sulfate/Oil	83	2.0	11	0.9	932	3.9	1.0
Dichlone/Sulfur	9	0.2	3	0.2	450	1.9	3.0
Kocide/Oil	12	0.3	3	0.2	219	0.9	1.0
Lime Sulfur/Sulfur	12	0.3	5	0.4	212	0.9	1.0
Oil/Tri-Basic	14	0.3	2	0.2	122	0.5	2.0
Other Misc. Chemicals	120	2.8	54	4.2	1092	4.6	5.3
Other Misc. Combinations	269	6.3	34	2.7	1150	4.9	1.8
Unidentified	3	0.1	2	0.2	427	1.8	1.0
Subtotal	4221	100.0	1282	100,0	23721	*.*	*.*
No Answer	8		3		90		
Total	4229		1285		23811		

1) Includes Multiple Applications
Source: (22).

Table I-18

Comparative Costs of Maneb and Alternatives for Brown Rot Control on Nectarines and Peaches

fungicide	product cost1/	application rate/acre2/	material per acre-treatment
maneb 80 W	$1.75/lb.	6 lbs.	$10.00
captan 50W	$1.25/lb.	6 lbs.	$ 7.50
dichloran 75w	$3.50/lb.	4 lbs.	$14.00

1/ Average material costs based on review of various pesticide price lists.
2/ Based on rates in California Peach and Nectarine pest control guide; assumes 300 gallons spray/acre (14).

Pears

Two types of EBDC fungicides-mancozeb and zineb- are EPA registered for control of various diseases of pears. In addition, both are registered for use against pear psylla, an insect pest of pears which can be controlled by these materials while in the nymph (pre-adult) stages. Alternatives are very limited for some of the pear diseases but are numerous for two of the most important diseases (fire blight and scab) (Table I-19). Registered alternatives for pear psylla include the following:

azinphosmethyl	parathion
carbaryl	perthane
endosulfan	phosmet
ethion	pyrenone
lime sulfur	toxaphene
malathion	morestan
oil	

Chlordimeform is an effective insecticide for psylla control which was voluntarily withdrawn from the market by its manufacturers in 1976. Although still registered for this use, it seems unlikely that chlordimeform will be available for use by pear growers in the near future. Amitraz is a relatively new insecticide which provides good psylla control and which has been available for use by pear growers during the 1977 and 1978 seasons under a Section 18 Emergency Use Permit. The future registration status of amitraz is now under review in EPA's RPAR procedure. Various synthetic pyrethroid materials, such as permethrin and fenvalerate, have also exhibited good psylla control capabilities and may be registered within the next few years.

Zineb is the only EBDC currently recommended for disease control on pears (Table I-20). Review of fungicide usage data for pears (Table I-21) and confidential sources indicates no reported use of zineb on pears for disease control. Available data indicate that about 3,500 acres of pears are treated with mancozeb annually for disease control. Approximately 45,000 pounds mancozeb are applied per year in 7,500 acre-treatments. California authorities indicate that certain alternative fungicides (such as benomyl) provide superior control of scab, the primary disease for which EBDCs are used on pears. Growers switching from mancozeb to alternatives would incur cost effects ranging from a savings of $.50 per acre (captan) to an increase of $6.00 per acre (benomyl). Assuming that benomyl, captan, and cyprex are each used on one-third of the acreage currently treated with mancozeb indicates total grower cost effects of approximately $15,000 per year (Table I-22). The overall effect of cancelling EBDCs for disease control on pears would be negligible.

Insecticide use survey data for pears indicates no use of EBDC materials for pear psylla control (Table I-23). However, the USDA economic impact analysis report for amitraz use on pears indicated that mancozeb would be routinely used in Oregon and Washington spray programs involving amitraz. Since amitraz has been available for use by Western pear growers in both 1977 and 1978, it is probably reasonable to conclude that EBDC use on pears has been significant. The amitraz analysis indicates that mancozeb is used in Oregon's Hood River area and in Washington State. Total use of mancozeb in Oregon and Washington approximates 289,000 pounds a.i. per year on about 25,000 acres (Table I-24).

Mancozeb is used during the spring and summer cover sprays to control psylla nymphs. If unavailable, growers would have to utilize alternative insecticides capable of controlling this pest which are compatible with orchard conditions during these use periods. Likely alternatives to mancozeb include amitraz (if available), endosulfan, pyrenone, phosmet, toxaphene, azinphosmethyl, and parathion. It is difficult to predetermine which of these materials would be the favored alternatives, and it is likely that all would be used to some extent. For the purposes of this analysis, it is assumed that all mancozeb acre-treatments would be replaced on an equal share basis by amitraz, endosulfan and phosmet. The use of these materials would increase grower treatment costs by about $231,000 (Table I-25) or $9.24 per affected acre per year.

The cancellation of EBDC's for use on pears to control pear psylla would seriously hamper grower efforts to control this insect, which is the most important pest of domestic pears. The psylla's immense reproductive potential has led to the point at which few insecticides now provide economic levels of control due to resistance. The loss of EBDCs will be critical if amitraz is also unavailable, since grower dependence upon EBDC's has been estimated to increase dramatically if amitraz is not registered. Pear grower use of mancozeb in Oregon and Washington is projected to increase from 289,000 pounds a.i. (amitraz available) to about 718,000 pounds a.i. if amitraz is unavailable due to increased reliance upon EBDCs for summer psylla control. Additionally, grower use of zineb would increase from little or none at present to about 126,000 pounds a.i. per year if amitraz is unavailable for use on pears. The use of EBDC's could also be increased to some extent as a result of an Agency action on perthane, an early season psylla control material, which is now undergoing pre-RPAR review.

TABLE I-19

EPA REGISTRATIONS OF EBDC'S AND ALTERNATIVES FOR CONTROL OF PEAR DISEASES[1/]

Fungicide	Diseases							
	Bitter rot	Black rot	Brown rot	Fire blight	Flyspeck	Rust	Scab	Sooty bloth
Mancozeb	M	M	M		M	M	M,Z	M,Z
Zineb				Z			M,Z	M,Z
Benomyl					M		M,Z	M,Z
Captan							M,Z	
Copper Bordeaux	M			Z			M,Z	
Copper hydroxide				Z				
Copper oxide				Z				
Copper oxychloride		M		Z			M,Z	
Copper oxychloride sulfate							M,Z	
Copper sulfate, basic							M,Z	
Copper sulfate, monohydrate				Z			M,Z	
Copper tetra copper calcium oxychloride				Z				
Dodine							M,Z	
Ferbam							M,Z	M,Z
Glyodin							M,Z	
Glyoxide							M,Z	
Sodium polysulfide							M,Z	
Streptomycin				Z				
Sulfur			M			M	M,Z	

1/ M = Registered uses of mancozeb and alternatives: Z = Registered uses of zineb and alternatives.

Source: (39)

Table I-20

SUMMARY OF STATE RECOMMENDATIONS FOR CONTROL OF PEAR DISEASES 1/

Fungicide	Disease											
	Bull's eye rot	Crown gall	Fire blight	Fruit rots 2/	Fruit spot	Leafspot 3/	Mildew	Pseudomonas blossom blast	Scab	Sooty blotch	Sooty mold	Storage rot
Zineb	—	—	—	PA,WA	PA	NY,NJ,PA	—	—	NJ,NY, PA	NJ,NY,PA	PA	OR
Bacticin	—	CA	—	—	—	—	—	—	—	—	—	—
Benomyl	—	—	—	PA	PA	NY,PA	—	—	NY,PA	PA,NY	PA	—
Bordeaux 4/	—	—	MI,NY,PA	—	—	MI	—	—	MI	—	—	—
Calcium polysulfide	—	—	—	—	—	—	WA	—	CA.WA	—	—	—
Captan	—	—	—	PA	PA	MI,NY,NY,OH, PA	—	—	CA,MI, NJ,OH, PA	NJ,NY,PA	PA	—
Copper (fixed)	—	—	CA,OR,WA	—	—	—	—	OR	—	—	—	—
Copper (other) 5/	—	—	CA,OR,WA	—	—	—	—	—	—	—	—	—
Dinocap	—	—	—	—	—	—	WA	—	—	—	—	—
Dodine	—	—	—	—	—	—	—	—	CA,OR,WA	—	—	—
Ferbam	—	—	—	PA	PA	MI,NY,PA	—	—	MI,NY, PA, WA	NY,PA	PA	—
lyodin	—	—	—	—	—	NY	—	—	NY	NY	—	—
orestan	—	—	—	—	—	—	WA	—	—	—	—	—
treptomycin 6/	—	—	CA,MI,NJ, NY,OH,OR, PA,WA	—	—	—	—	—	—	—	—	—
ulfur	—	—	—	—	—	OH	—	—	—	—	—	—
hiram	—	—	—	—	—	—	—	—	—	—	—	—
iram	WA	—	—	—	—	—	—	—	—	—	—	OR

/ This table summarizes the most recent available recommendations from the following states: California (CA), Michigan (MI), New Jersey (NJ), New York (NY), Ohio (OH), Oregon (OR), Pennsylvania (PA), and Washington (WA). This summary does not indicate specific problems, e.g., calcium polysulfide (lime sulfur) is not recommended for mildew control on Anjou pears in Washington. State recommendations should be closely consulted to evaluate substitutability of compounds.

/ Includes phytophthora rot.

/ Includes Fabraea and Mycosphaerella.

/ Includes recommendations in NY and PA for Bordeaux and oil combination.

/ Includes the following formulations: copper lime dust (CA), copper dust (OR), and copper sulfate and lime (WA).

urces: (18, 21, 26, 28, 31, 33, 34, 46,).

TABLE I-21 EXPENDITURES, TOTAL TREATMENT ACRES, GROWERS TREATING, AND AVERAGE NUMBER OF APPLICATIONS BY TYPE OF CHEMICAL APPLIED, AS ESTIMATED FOR 1975.

CROP: Pears
PRODUCT: Fungicides
AREA: Total U.S.

Type of Chemical	Expenditures Dollars (000)	Expenditures Pct.	Total Treatments 1) Acres (000)	Total Treatments 1) Pct.	Growers Treating Growers	Growers Treating Pct.	Avg. No. of Applications
Agri-Strep	229	9.9	38	10.6	3252	21.4	2.3
Ferbam	188	8.1	31	8.6	4228	27.9	4.3
Oil	47	2.0	13	3.6	268	1.8	1.3
Sulfur	106	4.6	15	4.2	447	2.9	1.3
Cyprex	114	4.9	18	5.0	550	3.6	1.6
Karathane	20	0.9	5	1.4	148	1.0	1.0
Maneb	12	0.5	3	0.8	117	0.8	3.0
Captan	77	3.3	28	7.8	6286	41.4	3.5
Benlate	130	5.6	19	5.3	1392	9.2	3.0
BSZ	28	1.2	3	0.8	117	0.8	3.0
C-O-C-S	485	21.0	43	11.9	327	2.2	7.9
Copper Sulfate	650	28.1	102	28.3	2064	13.6	6.2
Dithane M-45	8	0.4	1	0.3	148	1.0	1.0
Morestan	30	1.3	3	0.8	238	1.6	1.0
Lime Sulfur	32	1.4	2	0.6	241	1.6	1.0
Cyprex/Karathane	24	1.0	3	0.8	154	1.0	1.0
Other Misc. Chemicals	65	2.8	21	5.8	2262	14.9	4.3
Other Misc. Combinations	67	2.9	12	3.4	1150	7.6	2.7
Unidentified	2	0.1			157	1.0	
Subtotal	2314	100.0	360	100.0	15177	*.*	*.*
No Answer							
Total	2314		360		15177		

1) Includes Multiple Applications

Source: (22).

Table I-22

Comparative Costs of Mancozeb and Alternatives for Disease Control on Pears

fungicide	material cost1/	application rate/ acre2/	material cost/ acre	estimated acre-treatments	Total material cost
Mancozeb 80	$ 1.75/lb	6	10.50	7,500	$79,000
Benomyl 50	11.00/lb	1.5	16.50	12,500	41,000
Captan 50 WP	1.25/lb	8	10.00	2,500	25,000
Cyprex 65 WP	3.75/lb	3	11.25	2,500	28,000

1/ Material prices are averages derived from various pesticide price lists.

2/ Rates specified in California, Oregon, Pennsylvania pear recommendations. Mancozeb rate represents average label rate. Quantities based on 400 gallons of dilute spray per acre (18, 33, 34)

TABLE I-23 EXPENDITURES, TOTAL TREATMENT ACRES, GROWERS TREATING, AND AVERAGE NUMBER OF APPLICATIONS BY TYPE OF CHEMICAL APPLIED, AS ESTIMATED FOR 1975.

CROP: Pears
PRODUCT: Insecticides
AREA: Total U.S.

Type of Chemical	Expenditures		Total Treatments 1)		Growers Treating		Avg. No. of Applications
	Dollars (000)	Pct.	Acres (000)	Pct.	Growers	Pct.	
Diazinon	50	1.0	9	2.0	173	0.9	1.1
Perthane	75	1.5	10	2.2	2212	11.1	1.2
Fundal	169	3.5	16	3.5	569	2.9	1.5
Galecron	438	8.9	32	7.1	2141	10.7	2.1
Ethion	7	0.1	2	0.4	394	2.0	1.0
Guthion	575	11.7	75	16.5	9744	48.9	2.6
Imidan	82	1.7	14	3.1	2387	12.0	2.6
Parathion	14	0.3	2	0.4	1686	8.6	1.5
Sevin	65	1.3	16	3.5	2610	13.1	1.6
Sulfur	17	0.3	1	0.2	173	0.9	1.0
Thiodan	351	7.2	34	7.5	5547	27.8	2.4
Oil	219	4.5	40	8.8	4296	21.5	1.3
Zolone	78	1.6	19	4.2	4594	23.0	3.0
Morestan	46	0.9	3	0.7	540	2.7	1.0

Continued

1) Includes Multiple Applications

TABLE I-23 EXPENDITURES, TOTAL TREATMENT ACRES, GROWERS TREATING, AND AVERAGE NUMBER OF APPLICATIONS BY TYPE OF CHEMICAL APPLIED, AS ESTIMATED FOR 1975. (Continued)

CROP: Pears
PRODUCT: Insecticides
AREA: Total U.S.

Type of Chemical	Expenditures Dollars (000)	Expenditures Pct.	Total Treatments[1] Acres (000)	Total Treatments[1] Pct.	Growers Treating Growers	Growers Treating Pct.	Avg. No. of Applications
Plictran	57	1.2	11	2.4	394	2.0	1.1
Imidan/Oil	11	0.2	2	0.4	394	2.0	2.0
Guthion/Oil	216	4.4	31	6.8	727	3.6	2.0
Ethion/Oil	13	0.3	2	0.4	256	1.3	1.0
Perthane/Oil	209	4.3	16	3.5	736	3.7	1.1
Parathion/Oil	70	1.4	6	1.3	396	2.0	1.0
Thiodan/Oil	34	0.7	3	0.7	256	1.3	1.0
Guthion/Thiodan	13	0.3	1	0.2	173	0.9	1.0
Diazinon/Oil	158	3.2	10	2.2	331	1.7	1.0
Ethion/Guthion	50	1.0	9	2.0	173	0.9	1.1
Fundal/Galecron	205	4.2	7	1.6	265	1.3	1.7
Fundal/Thiodan	63	1.3	9	2.0	191	1.0	1.5
Galecron/Thiodan	87	1.8	5	1.1	302	1.5	1.5
Guthion/Plictran	91	1.9	13	2.9	158	0.8	1.0

Continued

1) Includes Multiple Applications.

TABLE I-23 EXPENDITURES, TOTAL TREATMENT ACRES, GROWERS TREATING, AND AVERAGE NUMBER OF APPLICATIONS BY TYPE OF CHEMICAL APPLIED, AS ESTIMATED FOR 1975.(Continued)

CROP: Pears
PRODUCT: Insecticides
AREA: Total U.S.

Type of Chemical	Expenditures Dollars (000)	Expenditures Pct.	Total Treatments[1)] Acres (000)	Total Treatments Pct.	Growers Treating Growers	Growers Treating Pct.	Avg. No. of Applications
Imidan/Plictran	9	0.2	3	0.7	112	0.6	1.5
Imidan/Thiodan	13	0.3	1	0.2	112	0.6	1.0
Oil/Sulfur	29	0.6	2	0.4	256	1.3	1.0
Parathion/Thiodan	29	0.6	2	0.4	241	1.2	1.0
Perthane/Thiodan	29	0.6	3	0.7	201	1.0	1.0
Oil/Perthane/Thiodan	83	1.7	6	1.3	596	3.0	1.0
Other Misc. Chemicals	848	17.3	12	2.7	1438	7.2	1.3
Other Misc. Combinations	393	8.0	27	6.0	3651	18.3	1.3
Subtotal	4896	100.0	454	100.0	19936	*.*	*.*
No Answer							
Total	4896		454		19936		

1) Includes Multiple Applications

Source: (22).

Table I-24

Estimated Use of Mancozeb for
Pear Psylla Control in Oregon and Washington

area/state	pear acres treated1/	pounds a.i. applied/acre treatment2/	no. acre-treatments/ year1/	quantity a.i. applied/acre/ year	total quantity a.i. applied/ year
Hood River, OR	3,200	7.2	1	7.2	23,000
Washington	15,215	7.2	1	14.4	219,000
Total Wash-	6,521	7.2	1	7.2	47,000
ington	21,736	- -	- -	- -	266,000
Total WA+OR	24,936	- -	- -	- -	289,000

1/ Acres treated and number of treatments per acre with mancozeb estimated based on representative spray schedules used in Oregon and Washington.

Source: (23).

2/ Assumes application of 9 pounds mancozeb 80% per acre-treatment = 7.2 pounds a.i.

Table I-25

Estimated Cost of Pear Psylla Control with Mancozeb and Selected Alternatives, Oregon and Washington

insecticide	material cost1/	application rate/ acre-treatment2/	material cost/ acre-treatment	acre-treatments/ year3/	total material cost/year
Mancozeb 80%	$ 1.75/lb	9 lbs	$15.75	40,151	$632,000
Amitraz 1.5EC	38.50/gal	1 gal	38.50	13,384	515,000
Endosulfan 50 WP	3.60/lb	5 lbs	18.00	13,384	241,000
Phosmet 50 WP	2.00/lb	4 lbs	8.00	13,384	107,000
					$863,000

1/ Averages based on review of various pesticide price lists.

2/ Rates based on product labels and Washington and Oregon pear spray schedule recommendations for pear psylla.

3/ Mancozeb use as derived in Table I-24. Use of alternatives assumes equal use of the three materials in place of mancozeb on an acre-treatment basis.

Almonds and Pecans

Maneb and metiram are the two EBDC fungicides registered for use on almonds and pecans, respectively. There are no registered alternatives to maneb for leaf spot, only one for twig blight, and just two registered alternatives for scab on almonds; a large number of alternatives are registered for brown rot and shot hole (Table I-26). Metiram is registered for use on pecans to control scab; five alternatives are also registered for this use (Table I-27).

The state of California accounts for virtually all of the almonds produced in the U.S. Maneb is recommended for control of brown rot on almonds in California, along with several other fungicides (Table I-28). Metiram is recommended for scab control in two major pecan-producing states, Oklahoma and Texas, which produce about 8% and 21% of the U.S. pecan crop, respectively. Three alternatives are recommended for scab in both Texas and Oklahoma and several other states (Table I-29).

Little fungicide use data is available to evaluate the use and importance of EBDC's in the production of almonds or pecans. The available national level survey data (confidential report for 1976) indicate no use of EBDC fungicides on either almonds or pecans; reported use of the registered and recommended alternatives is very high. However, California pesticide use data (Table I-8) shows that total EBDC use on almonds in the state (primarily maneb) in recent years has ranged from 30,925 pounds a.i. applied to 6,426 acres (1970) to 10,911 pounds a.i. applied to 2,281 acres (1972); in 1977, 10,986 pounds were applied to 1,952 acres. Since reported EBDC use in California may understate actual use by half, as many as 22,000 pounds a.i. may be applied to 4,000 acres of almonds in 1978. About 1% of the state's' 336,000 acres would receive EBDC treatments at this use level.

The use of benomyl or dichlone for brown rot control on almonds would increase grower costs per acre (relative to maneb) by $6.00 and $.64, respectively; use of captan in place of maneb reduces costs by $3.00 per acre-treatment (Table I-30). Under a worst-case assumption, the use of benomyl would increase production costs for almonds in California by about 0.6%, given replacement of one maneb treatment with benomyl and average production costs for almonds of about $950/acre. Assuming that benomyl replaces maneb on an average of 4,000 acres annually indicates maximum grower level cost impacts of $24,000 per year on the affected acreage.

Pecan growers currently using metiram for scab control on pecans would incur a maximum increase in treatment costs of about $3.75 per acre-treatment using alternatives (Benomyl 50WP = $8.30/lb. x .5 lb./100 gals. water x 300 gals/acre = $12.45. Metiram 80WP = $1.50/lb. x 2 lb./100 gals. water x 300 gals./acre = $9.00/acre). Since EBDCs are not used to an appreciable extent on pecans, the overall impact of cancelling EBDCs for this use would be negligible.

The immediate economic effect of cancellation of EBDC use on almonds and pecans would be negligible. Long term effects will also be minimal unless the number of alternatives declines due to regulatory action or reduction in effectiveness.

TABLE I-26

EPA REGISTRATIONS OF EBDC's AND ALTERNATIVES FOR CONTROL OF ALMOND DISEASES[1/]

Fungicide	Diseases: Brown rot	Leaf spot	Scab	Shothole	Twig blight
Maneb	M	M	M	M	M
Benomyl	M				
Calcium polysulfide				M	
Captan	M		M	M	M
Copper Bordeaux mixture	M			M	
Copper oxide				M	
Copper oxychloride sulfate	M			M	
Copper sulfate, basic	M			M	
Copper sulfate, monohydrate	M				
Copper tetra copper calcium oxychloride	M			M	
Ferbam	M			M	
Sodium pentachlorophenate				M	
Sulfur	M			M	
Ziram	M		M	M	

1/ M = Registered uses of Maneb and alternatives.

Source: (39)

TABLE I-27

EPA REGISTRATIONS OF EBDC's AND ALTERNATIVES FOR CONTROL OF PECAN DISEASES1/

ıgicide	Disease: Scab
:iram	M
ıomyl	M
ıper Bordeaux mixture	M
:ine	M
phenyltin hydroxide	M
am	M

M = Registered use of Maneb and alternatives.

rce: (39)

TABLE I-28

SUMMARY OF CALIFORNIA RECOMMENDATIONS FOR CONTROL OF ALMOND DISEASES

Fungicide	Disease Brown rot	Ceratocystis canker 1/	Crown gall	Leaf blight	Scab	Shothole
Maneb	X					
Bacticin			X			
Benomyl	X					
Bordeaux	X					
Captan	X			X	X	X
Copper (fixed)	X					
Dichlone	X					X
Sodium penta-chlorophenate	X			X		
Sulfur (wettable)					X	
Ziram				X	X	X

1/ Recommendation guide calls for removal of canker-infested area with a knife followed by painting of the wound.

Source: (17)

Table I-29

Summary of State Recommendations for Control of Pecan Diseases[1/]

Fungicide	Disease: blotch	brown leaf spot	downy spot	liver spot	nursery blight	powdery mildew	scab	vein spot	zonate leafspot
metiram							OK,TX		
benomyl	MS,SC	GA,LA,MS,SC TX	GA.LA, MS,SC, TX	LA	MS	GA,LA, SC	GA,LA, MS,NC OK,SC,TX	LA	GA
dodine	MS,SC	Al, GA,LA,MS.SC	Al, GA,LA, MS,SC	LA	MS	GA	Al, GA,LA MS,NC, OK,SC,TX	LA	
triphenyltin hydroxide	MS,SC	AL, GA,LA,MS,SC, TX TX	AL, GA,LA, MS,SC, MS,SC, TX	LA	MS	GA,LA	AL, GA,LA MS,NC, MS,NC, OK,SC,TX	LA	GA

1/ Does not include recommendations for rosette, a disease caused by zinc deficiency. State codes: AL = Alabama, GA = Georgia, LA = Louisiana, MS = Mississippi, NC = North Carolina, OK = Oklahoma, SC = South Carolina, TX = Texas.

Sources: (2,20,24, 27,29, 32, 35, 42).

Table I-30

Comparative Costs of Maneb and
Alternatives for Scab Control on Almonds

fungicide	material cost1/	application rate/acre2/	material cost per acre-treatment
maneb 80W	$ 1.75/lb.	6	$10.50
benomyl 50W	$11.00/lb.	1.5	$16.50
captan 50W	$ 1.25/lb	6	$ 7.50
dichlone 50W	$ 4.95	2.25 lb.	$11.14

1/ Average material costs based on review of various pesticide price lists.
2/ Based on application rates in California almond pest control guide; assumes 300 gallons spray per acre (17).

SOURCES CONSULTED

1. Alabama Cooperative Extension Service, 1975, Alabama Insect Control Guide, Auburn, 2-1-74 and 2-1-75.

2. Auburn University, 1975, Cooperative Extension Service, Alabama Insect Control Guide: 1975 Commercial Pecan Spray Schedule, 2-1-75.

3. California Crop and Livestock Reporting Service, 1976 California Fruit and Nut Acreage, Sacramento, June, 1977.

4. California Crop and Livestock Reporting Service, California Agriculture: California's Principal Crop and Livestock Commodities, Sacramento, 1975.

5. California Department of Agriculture, 1971, Pesticide Use Report 1970, Sacramento.

6. California Department of Agriculture, 1972, Pesticide Use Report 1971, Sacramento.

7. California Department of Agriculture, 1973, Pesticide Use Report 1972, Sacramento.

8. California Department of Food and Agriculture, 1974, Pesticide Use Report 1973, Sacramento.

9. California Department of Food and Agriculture, 1975, Pesticide Use Report 1974, Sacramento.

10. California Department of Food and Agriculture, 1976, Pesticide Use Report 1975, Sacramento.

11. California Department of Food and Agriculture, 1977, Pesticide Use Report 1976, Sacramento.

12. California Department of Food and Agriculture, 1978, Pesticide Use Report 1977, Sacramento.

13. California Department of Food and Agriculture, California's Rebuttal to Presumption Against Registration of EBDC Fungicides, September, 1977.

14. California Agricultural Experiment Station and Extension Service, 1973, Pest and Disease Control Program for Peaches and Nectarines, January.

15. California Agricultural Experiment Station and Extension Service, 1973a, Pest and Disease Control Program for Apricots, January.

16. California Agricultural Experiment Station and Extension Service, 1973b, Pest and Disease Control Program for Cherries, January.

17. California Agricultural Experiment Station and Extension Service, 1973c, Pest and Disease Control Program for Almonds, January.

18. California Agricultural Experiment Station and Extension Service, 1973d, Pest and Disease Control Program for Pears, January.

19. Clemson University, 1978, Agricultural Chemicals Handbook, Clemson.

20. Clemson University Cooperative Extension Service, 1978, Agricultural Chemicals Handbook: Pecan Spray Schedule, Clemson.

21. Cornell University, 1978, New York State Insecticide, Fungicide and Herbicide Recommendations, Ithaca.

22. Doane Agricultural Service, Inc., Current Pesticide Use and User Profiles for Selected Pesticide Intensive Crops, Report 4 of 6, Vol. II, Pesticide Use Data on Selected Specialty Crops, EPA Contract 68-01-1928, January, 1976.

22a. Hoyt, S.C., P.H. Westigard, and E.C. Burts, Effects of Two Synthetic Pyrethroids on the Codling Moth, Pear Psylla, and Various Mite Species in Northwest Apple and Pear Orchards, Journal of Economic Entomology, Vol. 71, No. 3, pp. 431-434.

23. Kuntz, B. Ted, Economic Implications of Amitraz (BAAM) Use on Pears, USDA, ESCS, NRED, June 1978.

24. Louisiana State University Cooperative Extension Service, 1976, Insect Control Guide: Spray Schedule for Control of Pecan Insects and Diseases, Publication 1838, March.

25. Luttner, Mark, EPA internal memorandum to Amitraz support team, Use of Amitraz Alternative Pesticides on Apple and Pear, July 7, 1978.

26. Michigan State University Cooperative Extension Service, 1975, Fruit Spraying Calendar for Commercial Fruit Growers, Bulletin 154, East Lansing, January.

27. Mississippi Cooperative Extension Service, 1976, Pecan Insect and Disease Control in Commercial Orchards, Publication 461, March.

28. New Jersey Cooperative Extension Service, 1976, Commercial Tree Fruit Production Recommendations for New Jersey, Bulletin 407-C, New Brunswick.

29. North Carolina State University, 1978, North Carolina Agricultural Chemicals Manual: Pecan Spray Program, Raleigh, January.

30. North Carolina Agricultural Extension Service, 1976, Peach Spray Program, Circular 407 and Supplement, Raleigh, January.

31. Ohio State University Cooperative Extension Service, 1977, Ohio Commercial Fruit Spray Guide, Columbus.

32. Oklahoma State Unversity Cooperative Extension Service, 1975, Handbook of Insect, Plant Disease and Weed Control: Pecan Insect Spray Schedule, January.

33. Oregon State University Extension Service, 1977 Rogue Valley Spray Schedule-Pears, Apples, and Peaches, Corvallis.

34. Pennsylvania State University Cooperative Extension Service, 1977, Tree Fruit Production Guide, University Park.

34a. Stanford Research Institute, 1977, The Economic Impacts of Failure to Register Ethylene-bisdithiocarbamates (EBDCs): Working Paper No. 2-Economic Impacts of Cancelling EBDC Use on Bananas, SRI Project 5941, prepared for Rohm and Haas Company, August.

35. Texas Agricultural Extension Service, 1975, Suggestions for Controlling Insects and Diseases on Commercial Pecans, Publication L-1350, College Station, March.

36. Texas Agricultural Extension Service, 1975, Suggestions for Controlling Insects and Diseases on Commercial Peaches and Plums, College Station, July.

37. U.S. Department of Agriculture, 1978, Non-Citrus Fruits and Nuts: 1977 Annual Summary-Production, Use, Value, Economics, Statistics, and Cooperatives Service, Washington, D.C., January 13.

37a. U.S. Department of Agriculture, 1978. Fruit Situation. TFS-207, Washington, D.C., July.

38. U.S. Department of Agriculture, USDA/State and EPA Cooperative Assessment of Ethylene-bisdithiocarbamate (EBDC) Fungicide Uses in Agriculture, Office of Environmental Quality Additives, USDA, Washington, D.C., April 1978.

39. U.S. Environmental Protection Agency, 1975, Office of Pesticide Programs, Criteria and Evaluation Division, Internal Review of Ethylene Bisdithiocarbamate Fungicides and Their Residues, February.

40. University of California, Division of Agricultural Sciences, Almond Production Costs in California, Leaflet 2231, Berkeley, November, 1975.

41. University of Georgia Cooperative Extension Service, 1977, Georgia Peach Disease and Insect Control Guide 1977, Bulletin 630, Athens, March.

42. University of Georgia, 1978, Cooperative Extension Service, Pecan Insects and Diseases and Their Control, Bulletin 644, Athens, April.

43. University of Kentucky Cooperative Extension Service, 1975, Stone Fruit Spray Schedule - 1975.

44. University of Maryland Cooperative Extension Service, 1977, Maryland Spray Schedules for Commercial Apple and Peach Growers, Bulletin 134.

45. Virginia Polytechnic Institute and State University, Extension Division, 1978, Chemical Control of Insects, Plant Diseases, Weeds, Blacksburg, January.

46. Washington State University Cooperative Extension Service, 1977, Spray Guide for Tree Fruits in Eastern Washi.gton, Bulletin 419, January.

47. West Virginia University Cooperative Extension Service, 1976, West Virignia Spray Bulletin for Commercial Tree Fruit Growers, Circular 436, January.

SUMMARY OF ECONOMIC IMPACT ANALYSIS

EBDC USE ON PLUMS AND PRUNES

A. USE: EBDC (Nabam, Zineb) use on plums and prunes.

B. MAJOR PESTS CONTROLLED: Black knot, brown rot, leaf spot.

Major recommended chemicals:

	black knot	brown rot	leaf spot
Benomyl*	x	x	x
Bordeaux		x	
Captan*	x	x	x
Copper		x	
Dichlone	x	x	x
Dichloran		x	
Difolatan*		x	
Ferbam	x	x	x
Sulfur	x	x	x
Thiram		x	x

* = RPAR or RPAR candidate.

Non-chemical controls: Orchard sanitation practices (pruning diseased limbs, removing wild cherry trees in vicinity which harbor the diseases, picking up drops) aid in preventing spread of diseases, but do not control them once established.

Comparative performance: Zineb is only EBDC used on plums/prunes, primarily to control black knot. Some is probably used in combination or rotation with benomyl to prevent benomyl resistance. Benomyl is most effective fungicide for diseases of plums/prunes in areas where resistance to benomyl has not occured.

Comparative Costs:

Fungicide	cost/acre-treatment
zineb 75WP	$ 6.53
benomyl 50 WP	12.45
captan 50 WP	6.48
dichlone 50 WP	6.24
ferbam 76 WP	5.67
sulfur 95%	2.68

Conclusion: Loss of nabam registrations for plums/prunes will have little or no impact on production. Loss of zineb will cause greater reliance upon benomyl, thus increasing the threat of widespread disease tolerance or resistance to benomyl. Recent data indicate that reliance on benomyl (sole alternative for Black Knot control) will cause resistance, leading to premature economic death of trees where Black Knot is present. Captan, dichlone, and sulfur will also have increased use if zineb is unavailable.

D. EXTENT OF USE: Little or no nabam used on plums/prunes. About 32,000 pounds zineb a.i., is applied to about 2,300 acres using 8,000 acre-treatments annually. Zineb is used on about 18% of plum/prune acres in several Eastern states (Michigan, Ohio, Pennsylvania, New York), which amounts to about 2% of U.S. acres. Small quantities of EBDCs are used in California on plums/prunes.

E. ECONOMIC IMPACTS:

Users:

Short-term: Cancellation of zineb would likely cause switch to benomyl (the sole effective black knot alternative) resulting in the following short-term impacts: $6 cost increase/acre-treatment (relative to zineb) or $21/acre/year, or an increase in per acre production costs of about 3.4% per year. Aggregate cost increase to growers of about $48,000 annually.

Long-term: If benomyl (an RPAR chemical) is cancelled or is relied on so heavily by growers that resistance or tolerance to benomyl develops, it is reasonable to conclude that at least 4,000 acres of Eastern plums and prunes subject to black knot pressure would gradually lose production to the point at which they would be prematurely pushed out. Assuming these areas were replanted to other orchard crops, a net cost establishment period of a few to several years would take place. Per acre establishment costs for plum/prune acres replanted to peaches or apples would average at least $1,100 and $1,700, respectively. Costs incurred by growers in future years to re-establish fruit orchards if black knot control fails could be as high as $6.8 million (current dollars). When this would occur cannot be predicted with any degree of certainty, but resistance development is considered likely to occur at some point.

Market, Consumer: Little or no market or consumer impact is expected in the short run if EBDC use on plums/prunes is cancelled. In the longer term, cancellation of zineb followed by cancellation of benomyl or resistance to benomyl (caused by reliance on benomyl as the sole effective fungicide) would eventually cause a loss of plum/prune production amounting to about 4% of average U.S. production annually, this effect would increase consumer prices for plums, prunes and their products (degree of price change undetermined).

F. LIMITATIONS OF ANALYSIS:

1. Analysis is based on 1975 usage data, which may not reflect current use patterns. Benomyl resistance may have developed in some areas since 1975, which would indicate greater use of zineb than the 1975 data indicates.
2. Analysis assumes equal control with EBDC alternatives in short-run.
3. Long-run impacts discussed here are potential; alternatives other than benomyl will be used; rate of development of disease resistance to benomyl is undetermined; RPAR status of benomyl and other alternatives does not necessarily infer cancellation.

G. SOCIAL/COMMUNITY IMPACTS: Not investigated.

H. PRINCIPAL ANALYST: Mark A. Luttner, Economist, Economic Analysis Branch, Benefits and Field Studies Division, EPA, December, 1978.

PRELIMINARY BENEFIT ANALYSIS OF EBDC USE ON PLUMS AND PRUNES

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PRELIMINARY BENEFIT ANALYSIS OF EBDC USE ON PLUMS AND PRUNES[1/]

CURRENT USE ANALYSIS

EPA Registration of EBDC's and Alternatives

Two EBDC fungicides - nabam and zineb - are EPA registered for control of various diseases of plums and prunes (Table I-31). As indicated in Table I-31, nabam is registered only for leaf curl of plums and prunes, while zineb is registered for brown rot, coryneum blight, leaf curl, leaf spot and scab on plums and prunes.

Registered alternatives to EBDC's are most numerous for control of brown rot (8 registrations) and most limited for scab and leaf spot (each has 3 registered alternatives).

1/ This report was prepared in cooperation with Keith S. Yoder, Assistant Professor of Plant Pathology, VPI&SU, and O .Ray Stanton, Agricultural Economist, NRED, USDA.

Table I-31 - EPA REGISTRATIONS OF EBDC'S AND ALTERNATIVES FOR CONTROL OF DISEASES OF PLUMS AND PRUNES

FUNGICIDE	DISEASE OR FUNGUS 1/				
	Brown Rot	Coryneum Blight	Leaf Curl	Leaf Spot	Scab
Nabam			0		
Zineb	X	X	X0	X	X
Benomyl	X				X
Calcium Oxychloride			0		
Calcium Polysulfide			X		
Captafol			0		
Captan	X				
Copper Bordeaux Mixture	X	X			
Copper Naphthenate		X			
Copper Oleate			X		
Copper Oxychloride	X	X			X
Copper Oxychloride Sulfate	X		0		
Copper Sulfate, Basic	X			X	
Copper Tetra Copper Calcium Oxychloride		X	0		
Dichlone		X			
Ferbam	X			X	
Sulfur	X	X		X	X

1/ X = Registered use of zineb and alternatives. 0= Registered use of nabam and alternatives.

Source: U.S. Environmental Protection Agency, 1975.

Recommendations for Use of EBDC's and Alternatives

Zineb is recommended by many plum and/or prune-producing states to control black knot,[1/] brown rot, and/or leaf spot. A review of disease control recommendation guides for numerous plum and prune-producing states in both the Eastern and Western U.S. (Table I-32) indicates that zineb is the fungicide of choice for black knot control. Alternatives such as benomyl, captan, dichlone, and sulfur appear to be the first-choice fungicides for brown rot control based upon the number of states recommending these compounds. Similarly, benomyl, captan, ferbam, and sulfur appear to be the materials of first choice for control of leaf spot on plums and prunes.

All recommendations for black knot are contained in the control guides of Eastern States, which appears to indicate that black knot is not a problem in the West. Of the recommendations surveyed, all states recommending zineb are located in the Eastern portion of the U.S. Materials other than zineb or benomyl are not acceptable for use against black knot due to ineffectiveness or phytotoxic potential (Yoder, 1978).

Nabam did not appear in the plum and/or prune recommendations of any of the state guides reviewed in this analysis.

1/ Although zineb and a few other materials are recommended for black knot control, no fungicides are registered for use against this disease.

DISEASES FOR WHICH EBDC FUNGICIDES ARE RECOMMENDED

FUNGICIDE		DISEASE/STATE(S) RECOMMENDING FUNGICIDES1/		
		Black Knot2/	Brown Rot3/	Leaf Spot
EBDC	Zineb	DE, MI, NJ, NY, OH, PA	DE, NJ, NY, PA, VA, WV	NY, PA
Non-EBDC	Benomyl	DE, NJ, PA	AL, CA, DE, KY, MI, NJ, NY, OH, PA, TX, VA, WV	KY, MI, NY, OH, PA
	Bordeaux		CA	
	Captan	DE, NJ, PA	AL, CA, DE, KY, MI, NJ, NY, OH, PA, TX, VA, WA, WV	MI, NY, OH, PA
	Copper (Fixed)		CA	
	Dichlone	DE, NJ, PA	CA, DE, KY, MI, NJ, NY, OH, PA, VA, WA, WV	NY
	Dichloran		TX	
	Difolatan		CA	
	Ferbam	PA	KY, MI, NY, PA	KY, MI, NY, PA
	Sulfur4/	DE, KY, NJ	AL, CA, DE, KY, MI, NJ, NY, OH, TX, WA	KY, MI, NY, OH
	Thiram		OH	OH

1/ Al = Alabama, CA = California, KY = Kentucky, MI = Michigan, NJ = New Jersey, NY = New York, OH = Ohio, PA = Pennsylvania, TX = Texas, VA = Virginia, WA = Washington, WV = West Virginia. Includes recommendations for plums and prunes: CA, NY, PA, VA, WA, WV. Plum recommendations only: AL, KY, MI, NJ, OH, TX.

2/ The West Virginia Guide includes black knot with brown rot in the prebloom disease spray and recommends benomyl, captan, or dichlone for control. However, the following statement is included as well: "There are no fungicides approved for "black knot" control on plums, prunes, or cherries. In those orchards where a good spray program for brown rot control is followed, black knot usually will not be a problem."

3/ Includes blossom blight and brown rot of fruit.

4/ Includes recommendations for sulfur, dusting sulfur, wettable sulfur, and liquid lime sulfur.

Sources: Alabama Cooperative Extension Service, 1975.
California Agricultural Experiment Station and Extension Service, 1973.
University of Delaware Cooperative Extension Service, 1976.
University of Kentucky Cooperative Extension Service, 1975.
Michigan State University Cooperative Extension Service, 1975.
New Jersey State University Cooperative Extension Service, 1975.
Cornell University, 1978.
Ohio State University Cooperative Extension Service, 1977.
Pennsylvania State University Cooperative Extension Service, 1977.
Texas Agricultural Extension Service.
Virginia Polytechnic Institute and State University, 1974, 1977.
Washington State University Cooperative Extension Service, 1977.
West Virginia University Cooperative Extension Service, 1976.

Zineb is the only EBDC used to an appreciable extent on domestic plums and prunes. Roughly 2,300 acres of plums and prunes were treated with zineb an average of 3.5 times in the U.S. in 1975 (Doane Agricultural Service, Inc., 1976). A total of 8,000 acre-treatments were applied to plums and prunes using zineb (Table I-33). Since no data are available to indicate a trend in the use of zineb over time, it is assumed that the 1975 use level is representative of current use patterns. Brown rot resistance to benomyl was first detected in late 1975, suggesting that use patterns may have changed since then. Benomyl usage may have peaked in critical black knot areas in 1975 and zineb's importance may well have increased in the interim.

Available zineb usage data (Appendix A) indicate that EBDC fungicides are most important to growers in the Eastern States. The data also show that black knot (the disease for which zineb is most widely recommended) was not reported to be a problem in the West. Plum/prune fungicide usage data for the U.S. as a whole (Eastern and Western states) show all domestic zineb use occurs in Eastern states, primarily for control of black knot (Tables 3, 4a, 4b of Appendix.) This conclusion is substantiated by pesticide use data from California, which indicate no reported use of zineb on plums or prunes in the state during the past four growing seasons (Table I-34). Therefore, for the purposes of this analysis, it is assumed that all EBDC usage on plums and prunes occurs in the Eastern producing states.[1/]

1/ Brown rot resistance to benomyl has occurred more recently in California (Yoder, 1978a). Thus, zineb or nabam may now be of greater importance than the most recent usage data suggest.

Zineb was reported used by 846 or about 22% of Eastern plum/prune growers (9% of U.S. growers) (Doane Agricultural Service, 1976). The 8,000 zineb acre-treatments applied to plums and prunes represent about 5% of all treatments applied to these crops in the U.S. and indicates an average annual use of approximately 31,500 pounds zineb active ingredient.[1/] The 2,300 acres of plums and prunes treated with zineb represent about 18% of Eastern and 2% of total U.S. plantings.

The fungicide use data in Appendix Table 4a indicate that zineb is the material of first choice for black knot control on plums and prunes. The ratios of zineb users to users of the second and third choice fungicides for black knot (ferbam and benomyl) are 3.8:1 and 4.4:1, respectively. These figures appear to indicate a rather strong growers preference for zineb over alternatives for black knot control on plums and prunes.

Although zineb appears to be the preferred material for black knot control, zineb was sixth in 1975 in terms of extent of use as measured by acre treatments (Table I-33). Benomyl was by far the most widely used plum/prune fungicide, accounting for 37% of total acre-treatments. Zineb also followed captan, ferbam, sulfur, and lime sulfur; these materials accounted for 19%, 9%, 7%, and 6% of all acre-treatments of fungicides applied to plums and prunes in 1975, respectively. However, it is stressed that the development of benomyl resistance since 1975 may have changed these use patterns considerably. If so, it is likely that zineb use is greater than the 1975 data indicate.

1/ This use figure is based on an application of 350 gallons of dilute spray per acre using zineb at the rate of 1.5 pounds zineb 75 WP per 100 gallons water (approximately 4 pounds zineb a.i./acre).

TABLE I-33 - EXPENDITURES, TOTAL TREATMENT ACRES, GROWERS TREATING, AND AVERAGE NUMBER OF APPLICATIONS BY TYPE OF CHEMICAL APPLIED, AS ESTIMATED FOR 1975

CROP: Plums & Prunes
PRODUCT: Fungicides
AREA: Total U.S.

Typical of Chemical	Expenditures Dollars (000)	Expenditures Pct.	Total Treatments 1/ Acres (000)	Total Treatments 1/ Pct.	Growers Treating Growers	Growers Treating Pct.	Avg. No. of Applications
Benlate	614	58.7	55	37.2	3204	55.3	2.3
Captan	115	11.0	28	18.9	1280	22.1	2.2
Dichlone	20	1.9	5	3.4	278	4.8	4.0
Difolatan	13	1.2	5	3.4	243	4.2	1.3
Ferbam	86	8.2	13	8.8	689	11.9	6.0
Lime Sulfur	71	6.8	9	6.1	272	4.7	1.8
Oil	18	1.7	5	3.4	295	5.1	1.0
Sulfur	17	1.6	10	6.8	834	14.4	3.0
Zineb	22	2.1	8	5.4	846	14.6	3.5
Ferbam/Sulfur	30	2.9	6	4.0	307	5.3	5.0
Other Misc. Chemicals	11	1.1	2	1.3	423	7.3	1.5
Other Misc. Combinations	28	2.7	2	1.3	307	5.3	3.0
Unidentified	1	0.1			75	1.3	
Subtotal	1046	100.0	148	100.0	5794	*.*	*.*
No Answer	8		1		70		
Total	1054		149		5864		

1/ Includes Multiple Applications

SOURCE: Doane Agricultural Service, 1976

TABLE I-34 - REPORTED USE OF EBDC FUNGICIDES ON PLUMS AND PRUNES IN CALIFORNIA, 1970-1977

		PLUMS		PRUNES	
YEAR	EBDC FUNGICIDE	QUANTITY APPLIED1/	ACRE-TREATMENTS	QUANTITY APPLIED1/	ACRE-TREATMENTS
1970	Maneb	1,290	92	167	119
	Nabam	1,270	281	25	17
	Zineb	53	88	--	--
1971	Maneb	--	--	144	30
	Nabam	509	127	--	--
	Zineb	1	3	--	--
1972	Maneb	74	15	--	--
	Zineb	3,025	286	--	--
1973	Maneb	40	10	--	--
	Zineb	677	106	110	145
1974	No reported use of EBDC's in 1974				
1975	No reported use of EBDC's in 1975				
1976	No reported use of EBDC's in 1976				
1977	Maneb	189	37	--	--

1/ Pounds of active ingredient.

SOURCE: California Department of Agriculture, 1970, 1971, 1972.
California Department of Food and Agriculture, 1973, 1974, 1975, 1976, 1977

Pest Infestation and Damage

Brown rot is a fungus disease which starts as a small, brown spot which rapidly increases in size until the entire fruit becomes brown and rotten; in the later stages, greyish spore masses appear on the rotted tissue. Brown rot blossom blight is the early season stage of this disease. Infected blossoms turn brown, shrivel, and dry up. The disease also spreads from the blossom onto the twigs, resulting in terminal blight (Teskey and Shoemaker 1972; Sharvelle and Scott, 1968; University of California, 1975).

Black knot is another fungus disease which attacks plums and prunes. The symptoms appear as large black cankerous-like growths on twigs, branches, and trunks. Control of the disease at this stage requires the removal of infected twigs and branches or the entire tree (Teskey and Shoemaker, 1972). Thus, the infected tree's bearing surface is temporarily reduced and yield is reduced proportionately (Yoder, 1978a). Trees severely infected with black knot become worthless in a few years from loss of vigor due to girdling of branches and trunks (Ritchie et al., 1975).

Leaf curl, leaf spot, and scab are other plum and prune diseases for which EBDC fungicides are registered. Leaf curl infection results in distortion and drop of leaves, which weakens the tree. Leaf spot disease appears in the form of purple-brown spots in leaves which fall out, causing a "shot-hole" effect and premature defoliation. Scab may infest leaves, twigs, and fruit; the symptoms are small, brown spots. When severe, scab will cause reduction in fruit yield and/or defoliation (Teskey and Shoemaker, 1972; Sharvelle and Scott, 1968).

Comparative Efficacy

Little comparative test data are available which directly evaluates the efficacy of EBDC's (zineb) and the leading alternative fungicides (benomyl, captan, sulfur, etc.) on plums and prunes. The three comparative tests available are summarized as follows:

In a 1970 Michigan test, Stanley prune trees were sprayed with one of several fungicides on May 12, 22, June 3, 12, July 6, August 11, 18. Materials were applied by hand gun at 350 psi. Leaf spot and defoliation ratings were made on October 9, 1970, with defoliation rated 0-10 and spots per leaf 0-5. Harvested fruits were held at room temperature and later rated for percent fruit brown rot. Test results are presented in Table I-35 (Klos et al., 1971).

Of the fungicides evaluated, the investigators reported that five, including benomyl and zineb, controlled leaf spot satisfactorily. The analysts also noted that trees treated with benomyl showed very little leaf russet as a result of mite damage.

Maneb was one of several fungicides applied to Early Italian prune trees in two Oregon tests during 1970. The results of the first test, which was intended to evaluate control of brown rot blossom blight and its effect upon yield, are presented in Table I-36. The test was unusual in that all observed yields were much lower than those normally anticipated (300 - 400 lb. per tree). No brown rot blossom blight occurred in any of the test plots, but the investigator noted that the significant yield increase in the maneb-treated plot indicated an effect which commonly occurs in some areas of Oregon during seasons when blossom blight does not occur. The yield increase effect (cause as yet undetermined) sometimes follows application of a maneb fungicide and some others (MacSwan, 1970a).

The second Oregon test in which maneb was utilized was performed to evaluate various fungicides for post-harvest control of brown rot fruit (Table I-37). Under the conditions of this test, none of the fungicides used provided control (MacSwan, 1970b).

TABLE I-35 RESULTS OF FUNGICIDE TEST ON STANLEY PRUNE TREES, 1970

Treatment and rate per 100 gallons	Leaf Spot		Percent fruit brown rot
	Defoliation 0-10	Spots/leaf 9-5	
Difolatan 4F 1.5 pt.	1.00	1.25	8.5
Benlate 50 W 8.0 oz.	0.25	2.00	23.0
Thynon 75W 8.0 oz.	1.75	2.00	18.5
TD 1771 70W 12.0 oz.	0.50	2.75	20.5
Zineb 75W 2.0 lb.	0.75	2.75	- -
EL-273 10W 5.4 oz.	5.50	3.75	36.5
Check	6.50	5.00	47.0
LSD .05	1.26	1.04	27.8
LDS .01	1.74	1.43	38.5

SOURCE: Klos et al., 1970.

Results of Fungicide Trials for the Control of Brown Rot Blossom Blight on Early Italian Prune Trees with Resulting Yield Impacts, Oregon, 1970

Treatment and rate per 100 gallons	Percent brown rot blossom blight	Yield (Avg. lb. per tree)
Benlate 50W 8.0 oz.	Nil	36.3
Benlate 50W 1.0 lb.	Nil	27.5
TH 439 50W 1.0 lb	Nil	38.6
Dithane M-22 80W 2.0 lb. + B-1956 2.0 oz.	Nil	63.0
Thynon 75W 1.0 lb. + B-1956 2.0 oz.	Nil	26.6
Liquid lime sulfur 1.0 gal.	Nil	19.7
Check	Nil	28.0

Source: MacSwan, 1970a.

Table I-37

Results of Fungicide Trials for the Control of Post-harvest Brown Rot Fruit Rot on Early Italian Prunes, Oregon, 1970

Treatment and per 100 gallons	Percent fruit rotted by brown rot	
	After 8 days common storage	After 14 days common storage
Benlate 50W 8.0 oz.	65.3	92.6
TH 439 50W 1.0 lb. + B-1956 2. oz.	64.3	90.5
Dithane M-22 80W 2.0 lb. + B-1956 2.0 oz.	68.5	95.6
Thynon 75W 1.0 lb. + B-1956 2.0 oz.	66.7	92.9
Liquid lime sulfur 1.0 gal.	57.1	86.7
Check	59.4	84.7

Source: MacSwan, 1970b.

Another Michigan test performed in 1972 and 1973 was conducted to determine, in part, whether systemic fungicides would provide control of the pathogen causing black knot on plum trees (Ritchie, et al., 1975). Stanley plum trees were sprayed with various fungicides in 1972 and 1973 using handgun equipment. The results of the 1972 tests (Table I-38) showed that all treatments gave significantly better control than the control (no treatment). In 1973, benomyl and thiophanate methyl gave excellent control, both being significantly better than the control or zineb. Captafol and dodine also gave better control than zineb but were not as effective as the systemics. The analysts indicated that infections found on trees treated with benomyl and thiophanate methyl were probably due to late timing of the initial spray. The investigators also noted that neither benomyl nor thiophanate methyl will arrest the growth of established knots.

The fungicide field test of greatest significance to this analysis was conducted in New York State during 1978 (Table I-38a). Several conclusions from this test are pertinent to the analysis of the benefits of zineb usage on plums and prunes (Yoder, 1978a).

The test site was a grower orchard which was on the verge of removal because of marginal profitability due to severe black knot infestation. The heavy black knot inoculum conditions resulted in a severe fungicide test for several important treatment schedules. Treatments in which zineb was included (No. 2 Dithane Z-78, 2 lb and No. 3 Benlate 2 oz + Dithane Z-78 1 lb) in the early season provided much better control of black knot than treatment No. 4 in which Benlate was applied alone at higher rates. These results differ drastically from our Michigan results of 1973 (Ritchie, Klos & Yoder, Plant Disease Reporter 59:499-503) in which Benlate 2 oz provided much better control than zineb 1.5 lb. This apparent reversal in relative effectiveness of the two compounds for black knot control casts further doubt upon the future reliability of benomyl as an alternate for zineb for this purpose (Yoder, 1978a).

TABLE I-38 RESULTS OF FUNGICIDE TRIALS FOR THE CONTROL OF BLACK KNOT ON "STANLEY" PLUM TREES DURING 1972 AND 1973 IN MICHIGAN

Treatment and Rate (a.i.per 100 gal water)	1972 Infections No. Knots/Tree (avg)	1973 Infections No. Knots/Tree (avg)
benomyl 2.0 oz	33 a*	6 a*
thiophanate methyl 5.6 oz	97 ab	6 a
captafol .75 lb	250 b	29 ab
dodine 3.9 oz	--	79 bc
zineb 1.5 lb	--	122 c
Control	1182 c	102 c

*Means followed by the same letter are not significantly different at 5% level (= .05).

SOURCE: Ritchie et al., 1975

Table I-38a

Results of 1978 Field Fungicide Trials
Grand Prize Prunes, Peter Sturges Farm, Red Hook, New York

D.A. Rosenberger, F.W. Meyer, and C.V. Cecilia

No.	Treatment and rate/100 gals.[1]	Spray dates	% fruit with latent brown rot[2]	No. of black knots/ 20 terminals[3]
1.	Check		77.2 b	67.6 c
:	Dithane Z-78 75W (2 lb.)	4/25,5/4	14.5 a	3.6 a
	Dithane Z-78 75W (1 lb.) + Captan 50W (1 lb.)	5/11, 5/18, 5/26, 6/5		
	Captan 50W (2 lb.)	8/8, 8/17, 8/24		
3.	Benlate 50W (2 oz.) + Dithane Z-78 (1 lb.)	4/25, 5/4	5.6 a	2.8 a
	Benlate 50W (4 oz.) + Dithane Z-78 75W (1 lb.) + Captan 50W (1 lb.)	5/11, 5/18, 5/26, 6/5		
	Benlate 50W (4 oz.) + Captan 50W (1 lb.)	8/8, 8/17, 8/24		
4	Benlate 50W (4 oz.)	4/25, 5/4	19.1 a	33.0 b
	Benlate 50W (8 oz.)	5/11, 5/18, 5/26, 6/5, 8/8, 8/17, 8/24		
5	Difolatan 4F (1 qt.)	5/11, 5/18, 5/26, 6/5, 8/8, 8/17	1.6 a	16.8 a
6.	Difolatan 4F (3 qt.)	4/25	61.3 b	36.2 b
	Benlate 50W (4 oz.) + Captan 50W (1 lb.) + Glyodin 30% (1 pt.)	8/18, 8/17, 8/24		

Th small letters indicate Duncan's multiple range groupings of treatments which do not di fer significantly at the 5% level.

[1]Other sprays included Imidan 50W (1.5 lb.) on 5/26 and 6/6, Imidan 50W (1 lb.) on 6/15, I idan 50W (1 lb.) + Plictran (4 oz.) on 7/7 and 8/8.

[2]Latent brown rot infections were evaluated by incubating 15 fruits per replicate (single-tree replicates) at room temperature for 9 days and counting the number o fruit developing brown rot. Fruit were picked 7/7 and were soaked in 1% chlorox for 2 min prior to incubation.

[3]B ack knot Infections on 20 terminals per replicate were counted August 24.

Relative ineffectiveness of benomyl on other fruit diseases (eg. brown rot of stone fruits and apple scab) has frequently been seen as a first indication of fungal resistance to benomyl to be subsequently confirmed through laboratory testing of the isolated organism. In this case, black knot resistance to benomyl is a distinct possibility which will be evaluated in the near future (Yoder, 1978a).

The results of two other field tests are available which indicate the effectiveness of a mjor EBDC alternative for brown rot (benomyl). Unfortunately, zineb was not included in either test. The results of these tests (Tables I-39 and I-40) are presented here to indicate the effectiveness of benomyl and captan for brown rot control on plums and prunes. Captan was ineffective at the 2.0 pound rate (Table I-40).

No test data are currently available which indicate the relative efficacy of EBDC's or alternatives for control of leaf curl or scab on either plums or prunes.

Comparative Yield/Quality

Based upon the fungicide use data presented in Appendix A (in particular, Table 4a), the experimental test data previously reported, the recommendations in state pest control guides, and other sources (Yoder 1978), it is assumed that the EBDC alternatives will provide acceptable short-term control of the major plum and prune diseases for which the EBDC's are registered (brown rot, leaf spot, scab, leaf curl, and coryneum blight).

Available information indicates that the sole effective EBDC alternative for black knot control is benomyl (Yoder, 1978). However, it may be premature to assume that benomyl can be substituted for zineb (in the event of a cancellation of EBDC's for plum and prune diseae control) on a one-for-one basis for the following reasons:

1. Benomyl (like zineb) is not registered for black knot control on plums and prunes.

2. Available usage data (Appendix A) indicate that, based on the number of growers reporting fungicide use for black knot control, zineb is the preferred material. This preference may be based on effectiveness, cost, historical use patterns, or a combination of the above.

3. A reliance on benomyl alone for black knot control may lead to control problems in future years due to the potential for fungal resistance to benomyl (Yoder, 1978).

TABLE I-39 RESULTS OF FUNGICIDE TEST ON STANLEY PRUNE PLUM TREES, 1974

Fungicide and rate per 100 gallons	% Fruit infected	% Disease Control
Untreated	21.5 a	0
Cela W-524 20% EC 10.0 oz	1.4 c	93.4
Cela W-524 20% EC 5.0 oz + Superior oil 1.0 qt.	6.9 b	67.8
Cela W-524 20% EC 10.0 oz + Nu-Film 17 1.0 pt .	0.8 c	96.1
Benlate 50W 4.0 oz.	0.6 c	97.1

The small letters indicate Duncan's multiple range groupings of treatments which do not differ significantly at the 0.5 level.

SOURCE: Perry, 1974.

TABLE I-40 RESULTS OF FUNGICIDE TEST ON EARLY ITALIAN PRUNES, 1974

Treatment and rate per 100 gallons	Percent Brown-Rotted Fruit
Benlate 50W 2.0 lb	0.25
Bravo 6F 24.0 oz.	1.50
BAY DAM 18654 50W 12.0 oz.	1.75
BAY MEB 6447 25W 8.0 oz.	2.50
Topsin M 70W 3.0 oz + Cypres 65W 0.25 lb	2.75
Captan 50W 5.0 lbs	3.00
Triforine 20EC 8.0 oz.	3.25
Topsin M 70W 3.0 oz + 1.0 qt Volck Supreme Oil	4.25
Triforine 20EC 4.0 oz.	4.50
Topsin M 70W 6.0 oz.	4.50
Captan 50W 2.0 lb.	6.00
Check	5.25

SOURCE: MacSwan and Moore, 1974.

4. The limited comparative efficacy information for zineb relative to benomyl is subject to some question, since the plum recommendations of at least two states - Delaware and New Jersey - include the following statement:

Black knot: Where this disease is serious, use zineb.[1/]

This information suggests that, in the short run, benomyl will provide adequate control of the plum and prune diseases for which EBDC's are currently used, including black knot. In the longer term, however, the potential for fungal resistance to benomyl may leave growers without an effective fungicide for black knot and would reduce the number of alternatives for control of brown rot, leaf curl, and scab. Based on previous experience with development of benomyl-tolerant fungus strains on apples, peaches, and cherries (Pennsylvania State University Cooperative Extension Service, 1977; Yoder, 1978a), it is probably reasonable to conclude that complete reliance upon benomyl for black knot control on plums/prunes would lead to fungal tolerance or resistance to benomyl within a few years. Without an effective fungicide for black knot, a minimum of 4,000 acres of plums and prunes (31% of Eastern U.S. acres) would gradually become infected and would be lost to production (Yoder, 1978, 1978a).

[1/] Source: New Jersey Cooperative Extension Service, 1976; University of Delaware Cooperative Extension Service: 1976.

Comparative Costs

This section of the analysis compares the per acre cost of treatment using EBDC fungicides and alternatives for plum and prune diseases.

The data in Table I-41 indicate that the chemical material cost of treatment using various recommended fungicides for plum/prune disease control ranges from $2.68 per acre (sulfur) to $12.45 per acre (benomyl). A grower switching from zineb to benomyl for black knot control would incur a cost increase of $5.92 per acre-treatment. Application costs would not be affected since the treatment method (generally air-blast or boom sprayers) would remain the same.

TABLE I-41 COMPARISON OF PER ACRE COSTS OF TREATMENT USING ZINEB AND ALTERNATIVES FOR PLUM/PRUNE DISEASE CONTROL

FUNGICIDE	QUANTITY PER ACRE 1/ (POUNDS FORMULATION)	FUNGICIDE COST PER ACRE 2/
zineb 75% WP	4.5	$ 6.53
benomyl 50% WP	1.5	12.45
captan 50% WP	6.0	6.48
dichlone 50% WP	1.5	6.24
ferbam 76% WP	5.25	5.67
sulfur 95%	15.75	2.68

1/ Rates for all fungicide except ferbam specified in: Cornell University, 1978. Ferbam rate represents average of two rates specified in: Pennsylvania State University Cooperative Extension Service, 1977.

2/ Represents product of quantity formulation per acre times price per unit. Fungicide prices represent current New York area prices for the formulations listed. Source: Agway, 1977.

ECONOMIC IMPACT ANALYSIS

Profile of Impact Areas

Plums are produced commercially in numerous states, but production is concentrated in five - Michigan, Oregon, California, Idaho and Washington. Of these states, California is by far the dominant producer, accounting for 91% of domestic plum and prune production (Table I-42).

Currently, there are approximately 145,000 acres of plums and prunes grown in the U.S.; and 13,000 acres (9%) are located in Eastern states and 132,000 acres (91%) are in Western states (Doane Agricultural Service, 1976). Of the Western total, California has 113,893 (86%) of western); 28% and 72% of the California acreage are plums and prunes, respectively.

In Michigan there are presently 7,400 acres of bearing plums and prunes (Michigan Crop Reporting Service, 1977). Scattered throughtout Eastern states (other than Michigan) are small acreages of plums and prunes. For example, there are 1,428 acres in New York and 528 acres in Pennsylvania (New York Crop Reporting Service, 1976; Greene, 1977).

TABLE I-42 PRUNES AND PLUMS: PRODUCTION AND SEASON AVERAGE PRICES RECEIVED BY GROWERS IN PRINCIPAL STATES, 1975, 1976, AND INDICATED 1977 PRODUCTION

CROP AND STATE	PRODUCTION			PRICE PER TON 1/	
	1975	1976	1977	1975	1976
		Tons		Dollars	
Prunes and plums: 2/	18,000	12,000	15,000	120.00	130.00
Michigan	4,000	7,000	7,000	200.00	242.00
Idaho	20,600	22,600	15,000	106.00	97.70
Washington	30,000	31,000	28,000	103.00	107.00
Total 4 States	72,600	72,600	65,000	113.00	119.00
Dried prunes: 3/					
California	149,000	145,000	152,000	402.00	428.00
Prunes:					
California	124,000	115,000	140,000	279.00	378.00
United States (fresh, basis)	650,000	626,000	661,000		

1/All price. 2/Mostly prunes, however, estimates include small quantities of plums in all States. Includes unharvested production and excess cullage (tons): total four States: 1975-3,000; 1976-3,500. 3/In California the dry ratio is 3.06: 1 for 1975 and 3.05 : 1 for 1976.

SOURCE: USDA, 1977.

The average size of plum/prune orchards in the East, West, and U.S. are 3.3 acres, 25.1 acres, and 15.8 acres, respectively (Doane Agricultural Service, 1976).

User Impacts

In the event EBDC fungicides are cancelled for use on plums and prunes, growers currently using zineb will switch to benomyl. The economic impact of the increased use of benomyl will be as follows:

Current zineb acre-treatments/yr 1/	Change in cost/acre - treatment with benomyl 2/	Total change in treatment cost/yr with benomyl
8,000	+ $5.92	+ $47,360

This level of impact indicates an average per acre cost impact on the 2,300 acres currently treated with zineb of about $21 per year. The average Eastern plum/prune orchard (3.3 acres) would incur a total cost effect of $69 per year. Given average annual per acre production costs in New York of approximately $625 3/, the cancellation of zineb and adoption of benomyl would increase production costs by 3.4% per year.

1/ Table I-33
2/ Table I-39
3/ Source: Snyder, 1976

[illegible] Agric. [illegible] Service. [illegible]).

e event 2,4-D [illegible]
e, growers currently [illegible]
le impact of the increased [illegible]

Change in cost/acre

treatments [illegible]

+ $1.42

of impact indicated [illegible]
acres currently [illegible]
[illegible] occupying [illegible]
effect of [illegible] per year. [illegible]
costs in [illegible]
of [illegible]
costs by 1.49 per year.

Growers may also have to increase cultural control practices (pruning out of infected branches and/or removal of trees) to insure that benomyl provides adequate black knot control. This activity would obviously increase production costs. However, the extent of this potential impact cannot be predetermined.

The economic effects caused by a reliance upon benomyl and increased cultural practices would be of an immediate nature. However, additional potential impacts may be significant, and are discussed as follows.

Benomyl, like the EBDC fungicides, is an RPAR chemical. Thus, it is conceivable that both zineb and benomyl could be cancelled by EPA based on human health and/or environmental risk factors. If this were to occur, plum/prune growers would be left without an effective fungicide for black knot (Yoder, 1978). Since black knot inevitably results in the economic death of infected trees (Ritchie et al., 1975), it is probably reasonable to assume that the estimated 4,000 acres (minimum) of Eastern plums and prunes consistently subject to black knot pressure (Yoder, 1978) would gradually go out of production, barring the introduction of an effective new fungicide.

It is virtually impossible to accurately predict the rate at which black knot infected areas would go out of production, since the disease can be controlled to an extent by cultural practices (pruning infected limbs or removal of trees). In addition, the incidence and seriousness of the disease is probably influenced by factors such as weather patterns, which obviously vary from year to year, from one region to another, and within regions.

It is also possible that complete grower dependence on benomyl may result in the same impact as a cancellation of both zineb and benomyl due to the problem of fungal resistance. Various sources have indicated the desirability of alternating benomyl with alternative fungicides or using combination sprays to inhibit or prevent the development of fungal resistance to benomyl (Yoder, 1978; Cornell University, 1978; Pennsylvania State University Cooperative Extension Service, 1977).

Most of the plum/prune acreage which would be pushed out due to uncontrolled black knot is probably located in Michigan. During the period 1972-1976, the average value of production per acre for Michigan plums and prunes was $274, while apples, peaches, sweet cherries, and tart cherries provided per acre value of production averages during the same period of $713, $380, $513, and $635, respectively (Michigan Crop Reporting Service, 1977). These figures do not indicate profitability (they represent gross revenue), but it is probably reasonable to assume that a change to fruit crops other than plums or prunes would provide growers with returns at least as high as those currently derived. However, the loss of plum and prune plantings due to black knot and subsequent establishment of apples, cherries, peaches, or other fruit crops would result in growers absorbing establishment and maintenance costs for the new orchards which in most cases would not occur if black knot control had been maintained.

The length of the net cost period (planting to initial production) would vary depending upon the crop planted, from about three years (peaches) to seven or eight years (apples). Per acre establishment costs for peaches (3 years) and apples (7 years) would be expected to average at least $1,100 and $1,700, respectively (North Carolina Agricultural Extension Service, 1976). Thus, the cost incurred by growers in future years to establish new fruit orchards if black knot control fails (due to a cancellation of zineb allowed by either cancellation of benomyl or development of fungal resistance to benomyl) could be as high as $6,800,000 (in current dollars; 4,000 acres of plums/prunes x $1,700 per acre establishment cost for apples).[1/] To this impact estimate should be added the value of plum/prune production lost as the trees decline due to a lack of black knot control on the affected acres. No attempt will be made to quantify this factor, since the rate of tree decline would vary widely depending on weather and the effectiveness of cultural control measures and alternative fungicides (other than benomyl) which would be applied as stop-gap measures.

1/ This impact estimate assumes that the affected plum/prune acreage would otherwise have remained in production.

Market/Consumer Impacts

Little market or consumer impact is indicated by the potential cancellation of EBDC fungicides for use on plums and prunes, at least in the short run. In the longer term, a cancellation of zineb followed by a cancellation of benomyl or the development of fungal resistance to benomyl would lead to a decline in Eastern plum/prune production. The decline of 4,000 acres in the East would reduce domestic production by roughly 3.9% (all other things being equal).1/ No data are available to indicate the exact impact of such a yield reduction upon retail plum or prune prices, but it is reasonable to conclude that some retail price increases would occur.

It is stressed that the production and price impacts discussed above are potential effects. No production or price effect resulting from a cancellation of EBDC fungicides for use on plums and prunes is immediately indicated, since:

1) Fungal (i.e. black knot, brown rot) resistance or tolerance to benomyl on plums or prunes has not yet been demonstrated, although these problems have occured in other orchard crops. Brown rot (Monilinia fructicola) will infect nearly all stone fruits including plums and prunes. Benomyl-resistant brown rot was detected in 1975 on sweet cherries in two important fruit counties in Michigan which include sizeable prune acreages (Figures I-1 and I-2).

2) The position of benomyl and other plum/prune fungicides as RPAR pesticides does not necessarily infer cancellation.

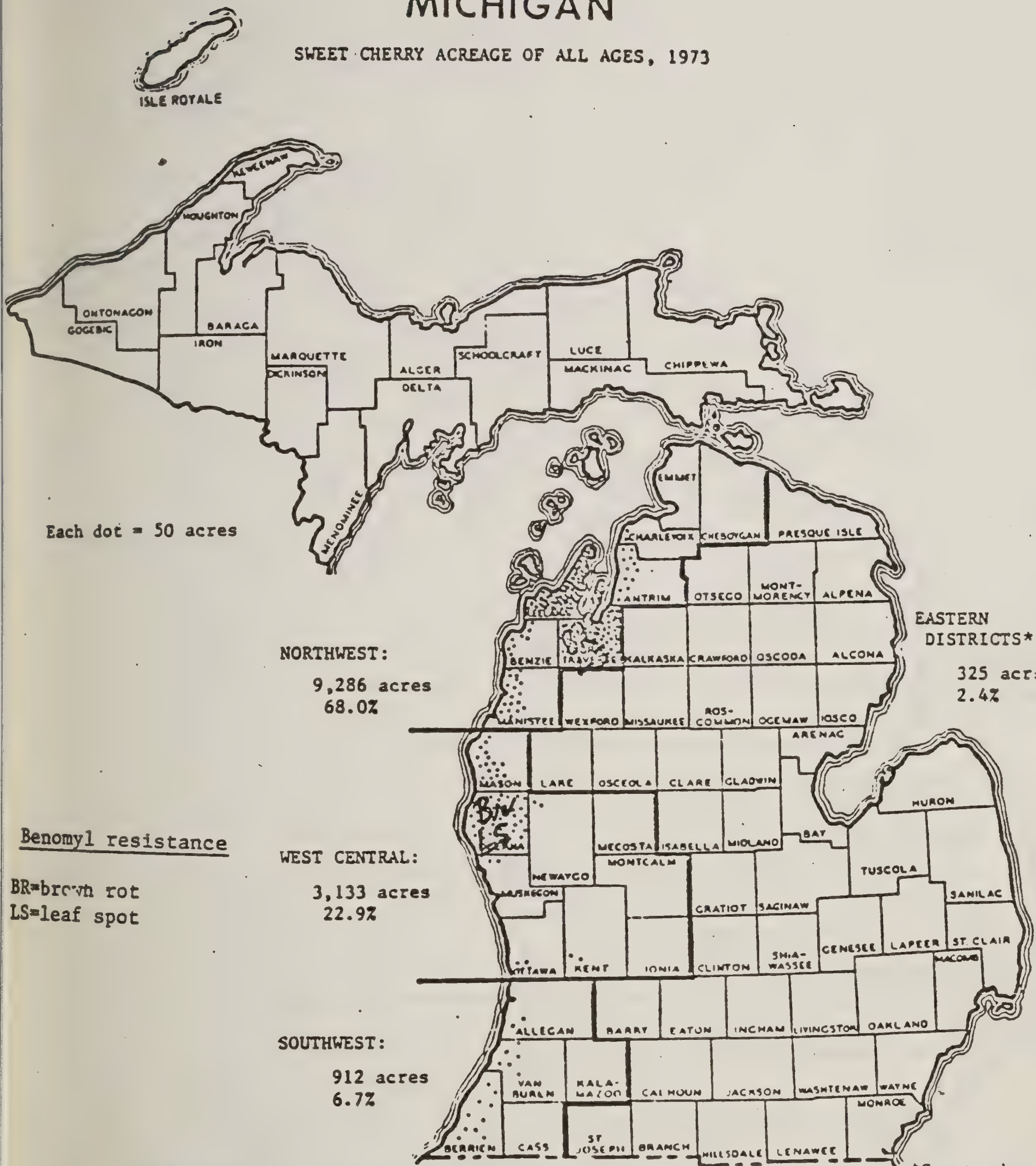
3) The analysis disregards the control (partial or better) provided by fungicide alternatives other than benomyl and cultural practices. The other alternatives would certainly be used by growers in the event zineb and benomyl are cancelled or benomyl becomes ineffective due to resistance, even though phytotoxicity may be problematic and their effectiveness is relatively low.

1/ Calculated assuming an average yield of 235 bushels per acre, 56 pounds per bushel, loss on 4,000 acres, and average annual U.S. plum and prune production of 646,000 tons.

Figure I-1

MICHIGAN

SWEET CHERRY ACREAGE OF ALL AGES, 1973



Each dot = 50 acres

NORTHWEST:
9,286 acres
68.0%

EASTERN DISTRICTS*:
325 acres
2.4%

Benomyl resistance

BR=brown rot
LS=leaf spot

WEST CENTRAL:
3,133 acres
22.9%

SOUTHWEST:
912 acres
6.7%

STATE TOTAL: 13,656 acres 100%

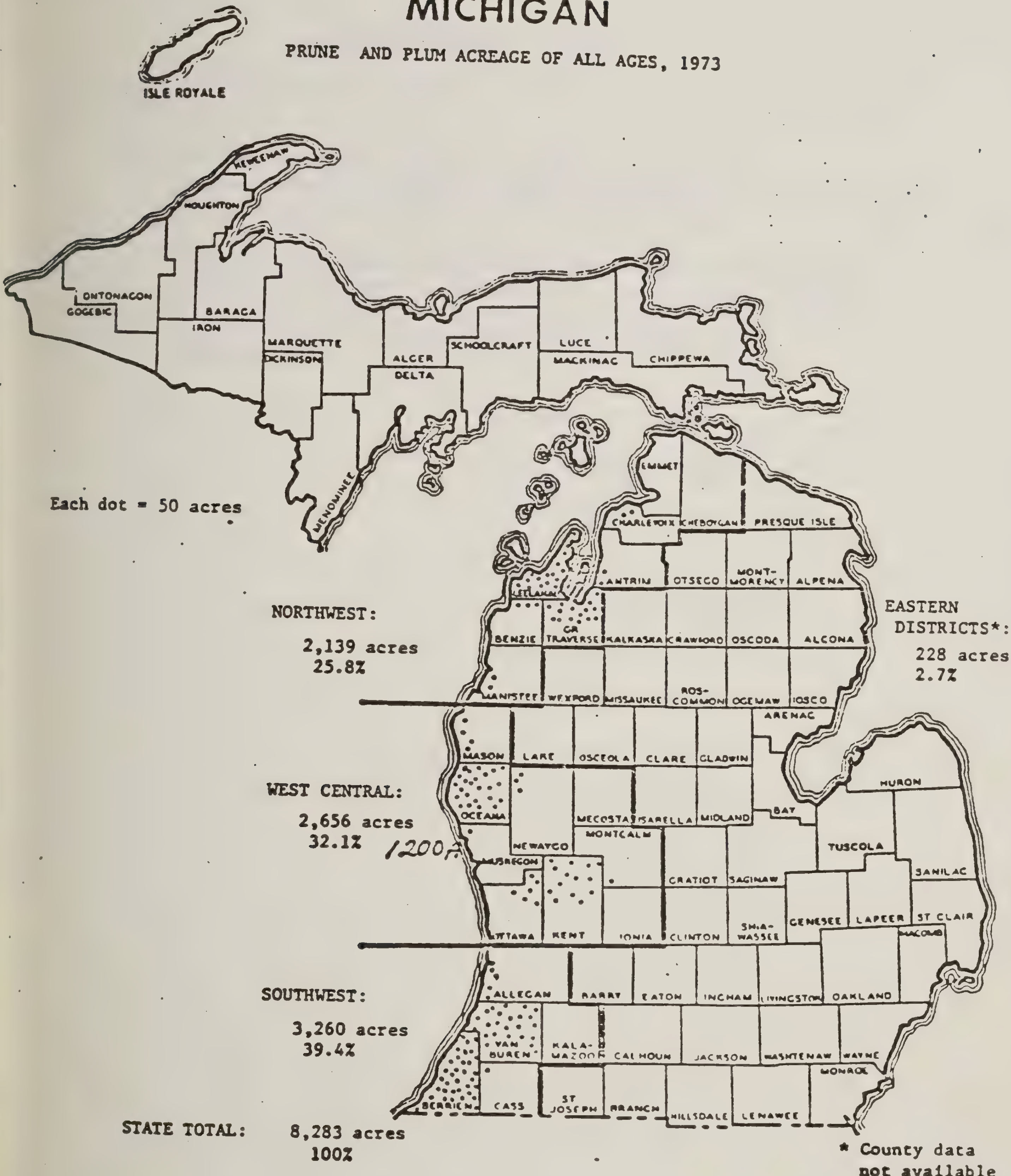
*County data not available

Source: Yoder, 1978a.

Figure I-2

MICHIGAN

PRUNE AND PLUM ACREAGE OF ALL AGES, 1973



Source: Yoder, 1978a.

Limitations of the Analysis

This analysis was prepared subject to the following assumptions and limitations:

1) Current EBDC use patterns on plums and prunes are assumed to be the same as those experienced in 1975, the most recent year for which data are available.

2) The analysis assumes comparable short-term control using EBDC fungicides and alternatives (in particular, benomyl is assumed to effectively replace zineb for black knot control) given an equal number of treatments using alternatives.

References

Agway, Inc., 1977, Pesticide Price List, Syracuse, New York.

Alabama Cooperative Extension Service 1975, Alabama Insect Control Guide - Commercial Spray Schedule for Peaches and Plums, Auburn University, Auburn, 2/1/74 and 2/1/75.

California Agricultural Experiment Station and Extension Service, 1973, Pest and Disease Control Program Plums and Prunes, January.

California Crop and Livestock Reporting Service, 1977, 1976 California Fruit and Nut Acreage, Sacramento.

California Department of Agriculture, 1970, Pesticide Use Report, Sacramento.

California Department of Agriculture, 1971, Pesticide Use report, Sacramento.

California Department of Agriculture, 1972, Pesticide Use report, Sacramento.

California Department of Food and Agriculture, 1973, Pesticide Use report, Sacramento.

California Department of Food and Agriculture, 1974, Pesticide Use report, Sacramento.

California Department of Food and Agriculture, 1975, Pesticide Use report, Sacramento.

California Department of Food and Agriculture, 1976, Pesticide Use report, Sacramento.

California Department of Food and Agriculture, 1977, Pesticide Use report, Sacramento.

Cornell University, 1978, New York State Insecticide, Fungicide, and Herbicide Recommendations, Ithaca.

Doane Agricultural Service, Inc., 1976, Current Pesticide Use and User Profiles for Selected Pesticide Intensive Crops, Report #4 Pesticide Use Data on Selected Speciality Crops. Volume II, EPA Contract #68-01-1928.

Greene, George M., 1977, The Vole Problem in Pennsylvania Apple Orchards, Proceedings of the First Eastern Pine and Meadow Vole Symposioum, Winchester, Virginia, March.

Klos, E.J., Yoder, K., and R. Miller, 1970, Prune: Leaf Spot and Brown Rot, Fungicide and Nematicide Tests, Results of 1970, American Phytopathological Society, Volume 26.

MacSwan, Iain C., 1970a, Prune (Early Italian): Brown Rot Blossom Blight and Yield, Fungicide and Nematicide Tests, Results of 1970, American Phytopathological Society, Volume 26.

MacSwan, Iain C., 1970b, Prune (Early Italian): Brown Rot Fruit Rot, Fungicide and Nematicide Tests, Results of 1970, American Phytopathological Society, Volume 26.

MacSwan, Iain C., and Bernard J. Moore, 1974, Prune (Early Italian): Brown Rot, Fungicide and Nematicide Tests, Results of 1974, American Phytopathological Society, Volume 30.

Michigan Crop Reporting Service, 1977, Michigan Agricultural Statistics 1977, Lansing.

Michigan State University Cooperative Extension Service, 1975, Fruit Spraying Calendars for Commercial Fruit Growers, East Lansing, January.

References cont'd.

New Jersey Cooperative Extension Servicee, 1976, Commerical Tree Fruit Production Recommendations for New Jersey, New Brunswick.

New York Crop Reporting Service, 1976, New York Orchard and Vineyard Survey, 1975, Albany, June.

North Carolina Agricultural Extension Service, 1976, Fruits: Planning for Profit, Circular 521, Raleigh, July.

Ohio State University Cooperative Extension Service, 1977, Ohio Commercial Fruit Spray Guide, Columbus.

Pennsylvania State University Cooperative Extension Service, 1977, Tree Fruit Production Guide, University Park.

Perry R.S., 1974. Plum: Brown Rot, Fungicide and Nematicide Tests, Results of 1974, American Phytopathological Society, Volume 30.

Ritchie, D.F., E.J. Klos, and K.S. Yoder, 1975, Epidemiology of Black Knot of "Stanley" Plums and Its Control with Systemic Fungicides, Plant Disease Reporter, Vol. 59, No. 6. June.

Rosenberger, D.A., F.W. Meyer, and C.V. Cecilia, 1978. Results of 1978 Field Fungicide Trials: Grand Prize Prunes, Peter Sturges Farm, Red Hook, New York.

Sharvelle, Eric G., and Donald H. Scott, 1968, Peach Diseases: An Aid to Identification and Control, Publication BP-3-12, Department of Botany and Plant Pathology, Purdue University.

Snyder, Darwin, P., 1976. Fruit and Vegetable Crops Costs and Returns from Farm Cost Accounts, Factors from 3 Enterprises of Prunes, publication A.E. Res. 76-26, Cornell University, Ithaca, New York, December.

Texas Agricultural Extension Service, Suggestions for Controlling Insects and Diseases on Commercial Peaches and Plums, College Station.

U.S. Department of Agriculture, 1977, Economic Research Service, Fruit Situation, Washington, D.C. September.

U.S. Environmental Protection Agency, 1975, Office of Pesticide Programs, EPA Compendium of Registered Pesticides, Volume II: Fungicides and Nematicides (supplement II).

U.S. Environmental Protection Agency, 1975, Office of Pesticide Programs, Criteria and Evaluation Division, Internal Review of Ethylene Bisdithiocarbamate Fungicides and Their Residues, February.

University of California, Division of Agricultural Sciences, Commerical Plum Growing in California, Leaflet 2458, November, 1976.

University of Delaware Cooperative Extension Service, 1976, Commercial Tree Fruit Production Recommendations for Delaware, Extension Bulletin 48-B, Newark.

University of Kentucky Cooperative Extension Service, 1975, Stone Fruit Spray Guide, Lexington.

References cont'd.

Virginia Polytechnic Institute and State University, 1974, Extension Division, Virginia Spray Bulletin for Tree Fruits, Blacksburg.

Virginia Polytechnic Institute and State University, 1977, Extension Division, Virginia Pest Management Guide, Blacksburg.

Washington State University Cooperative Extension Service, 1977, Spray Guide for Tree Fruits in Eastern Washington, Pullman.

Yoder, Keith S., 1978, Assessment of Benefits and Usage of Ethylene Bis Dithiocarbamate (EBDC) Fungicides in Tree and Small Fruit Producton, in USDA/State/EPA "Assessment of Ethylene bisdithiocarbamate (EBDC) Fungicide Uses in Agriculture," Washington, D.C., April.

Yoder, Keith S., 1978a, Assistant Professor of Plant Pathology, Virginia Polytechnic Institute and State University, Winchester, Personal Communication, December 15, 1978.

APPENDIX A: PLUM/PRUNES FUNGICIDE USE DATA

TABLE 1: NUMBER OF ACRES GROWN, ACRES TREATED, ACRES NOT TREATED, GROWERS, USERS, AND NON-USERS OF FUNGICIDES, TOTAL TREATMENT ACRES, AND TOTAL DOLLARS BY AREA, AS ESTIMATED FOR 1975.

CROP: Plums & Prunes
PRODUCT: Fungicides

	Total U.S.	West
Acres Grown(000)	145	132
Acres Treated(000) 1)	58	46
Acres Not Treated(000)	87	86
Number of Growers	9175	5250
Users of Fungicides	5864	2100
Non-Users of Fungicides	3311	3150
Total Treatment Acres(000) 2)	149	69
Total Dollars(000)	1054	555

1) Does Not Include Multiple Applications

2) Includes Multiple Applications

Source: 1972, 1973, and 1974 Doane Specialty Crops Studies.

TABLE 2: EXPENDITURES, TOTAL TREATMENT ACRES, GROWERS TREATING, AND AVERAGE NUMBER OF APPLICATIONS BY TYPE OF CHEMICAL APPLIED, AS ESTIMATED FOR 1975.

CROP: Plums & Prunes
PRODUCT: Fungicides
AREA: Total U.S.

Type of Chemical	Expenditures Dollars (000)	Expenditures Pct.	Total Treatments[1)] Acres (000)	Total Treatments[1)] Pct.	Growers Treating Growers	Growers Treating Pct.	Avg. No. of Applications
Benlate	614	58.7	55	37.2	3204	55.3	2.3
Captan	115	11.0	28	18.9	1280	22.1	2.2
Dichlone	20	1.9	5	3.4	278	4.8	4.0
Difolatan	13	1.2	5	3.4	243	4.2	1.3
Ferbam	86	8.2	13	8.8	689	11.9	6.0
Lime Sulfur	71	6.8	9	6.1	272	4.7	1.8
Oil	18	1.7	5	3.4	295	5.1	1.0
Sulfur	17	1.6	10	6.8	834	14.4	3.0
Zineb	22	2.1	8	5.4	846	14.6	3.5
Ferbam/Sulfur	30	2.9	6	4.0	307	5.3	5.0
Other Misc. Chemicals	11	1.1	2	1.3	423	7.3	1.5
Other Misc. Combinations	28	2.7	2	1.3	307	5.3	3.0
Unidentified	1	0.1			75	1.3	
Subtotal	1046	100.0	148	100.0	5794	*.*	*.*
No Answer	8		1		70		
Total	1054		149		5864		

1) Includes Multiple Applications

Source: 1972, 1973, and 1974 Doane Specialty Crops Studies.

TABLE 2: EXPENDITURES, TOTAL TREATMENT ACRES, GROWERS TREATING, AND AVERAGE NUMBER OF APPLICATIONS BY TYPE OF CHEMICAL APPLIED, AS ESTIMATED FOR 1975.

CROP: Plums & Prunes
PRODUCT: Fungicides
AREA: West

Type of Chemical	Expenditures		Total Treatments 1)		Growers Treating		Avg. No. of Applications
	Dollars (000)	Pct.	Acres (000)	Pct.	Growers	Pct.	
Benlate	330	60.2	32	49.2	867	43.0	1.6
Captan	82	15.0	11	16.9	331	16.4	1.1
Difolatan	13	2.4	4	6.2	194	9.6	1.0
Lime Sulfur	71	12.9	8	12.3	137	6.8	2.0
Oil	18	3.3	4	6.2	165	8.2	1.0
Sulfur	6	1.1	3	4.6	165	8.2	2.0
Other Misc. Chemicals	21	3.8	2	3.1	240	11.9	1.0
Other Misc. Combinations	7	1.3	1	1.5	137	6.8	1.0
Subtotal	548	100.0	65	100.0	2017	*.*	*.*
No Answer	7		4		83		
Total	555		69		2100		

1) Includes Multiple Applications

Source: 1972, 1973, and 1974 Doane Specialty Crops Studies.

TABLE 3: GROWERS REPORTING PEST PROBLEMS THEY WERE NOT ABLE TO CONTROL TO THEIR SATISFACTION BY AREA, AS ESTIMATED FOR 1975.

CROP: Plums & Prunes
PRODUCT: Fungicides

Pest	Growers Total U.S.	Pct.	Growers West	Pct.
Black Knot	384	37.2		
Brown Rot	435	42.1	358	61.8
Rot	435	42.1	358	61.8
Scab	138	13.4	138	23.8
Other	56	5.4	56	9.7
Total Indicating	1033	*.*	579	*.*

Source: 1972, 1973, and 1974 Doane Specialty Crops Studies.

TABLE 4: NUMBERS OF GROWERS MENTIONING PEST PROBLEMS AND SPECIFIC CHEMICALS FOR CONTROL, AS ESTIMATED FOR 1975.

CROP: Plums & Prunes
PRODUCT: Fungicides
AREA: Total U.S.

Chemical	PEST: Black Knot	Brown Rot	Scab
Benlate	159	2763	
Captan	77	955	118
Dichlone	77	201	
Difolatan		142	71
Ferbam	183	536	
Lime Sulfur	77	147	
Oil		124	101
Sulfur		609	
Zineb	692	231	
Ferbam/Sulfur		230	

Note: Data not available to make estimations on the following fungi found on Table 3: Rot, Black Knot.

Source: 1972, 1973, and 1974 Doane Specialty Crops Studies.

A. USE: Zineb use on citrus (primarily on oranges and grapefruit).

B. MAJOR PESTS CONTROLLED: Fungi: greasy spot; mites: citrus rust mites

C. ALTERNATIVES:

Major registered chemicals: Greasy spot:
RPAR : benomyl
Non-RPAR: basic copper sulfate, copper, petroleum distillate copper,
Citrus rust mite: RPAR: chlorobenzilate
Non-RPAR: Carbophenothion, dicofol, ethion, fenbutatin, oil, propargite, sulfur.

State/Federal recommendations: Number of alternatives recommended:
Greasy spot:
Florida: 3, Texas: 2, USDA: 1*.
Citrus rust mite:
California rust mite:
California: 2; Florida: 12; Texas: 10.
USDA: 7.
*currently being revised.

Non-chemical controls: Greasy spot: removing leaf litter from the grove floor so as not to provide the medium for the growth of the disease.
Citrus rust mites: predacious mites and insects.

Efficacy of alternatives: Greasy spot: Benomyl appears to be the best control currently available on the market. Though effective in terms of control, drawbacks associated with copper and oil make them less useful to the grower.
Rust mites: Clorobenzilate provides good control while not affecting predators and parasites of other citrus pests. Sulfur is effective for short period control, but continued use may lead to increases in armored scale and spider mite populations, and soil chemistry problems.

Comparative performance: Not investigated due to data limitations.

Comparative costs:

Greasy spot:

Pesticide	Cost/acre
Zineb	$19.94
Benomyl	$17.43
Copper	$ 4.80
Oil	$10.30

Rust mites:

Pesticide	Cost/acre
Chlorobenzilate	$11.61
Sulfur	$ 2.67
Ethion/Oil	$16.71

Conclusion: There are a number of pesticides, both RPAR and non-RPAR, that are more effective than zineb to control greasy spot and citrus rust mites. In addition, because zineb's toxicity to mites is confined to rust mites, its use as a miticide is a duplication of the toxic effects of miticides used as part of a control plan for all mites.

D. EXTENT OF USE:

Active ingredient basis, for Florida and Texas (pounds, a.i.)

Greasy Spot:
Zineb - 444,375 - 592,500
Benomyl - 34,800 - 69,600
Oil -6,920,000 - 10,380,000
Citrus Rust Mite
Zineb - unknown
Other - not investigated

Units treated basis, for Florida and Texas

Greasy Spot

Pesticide	Acres treated	Percent
Zineb	79,000	5%
Benomyl	29,000	1
Copper	534,000	21
Oil	692,000	28
Other	1,127,000	45
Total	2,517,000 1/	100
not treated	64,000	7.5% of acres grown

Citrus Rust Mite

Pesticide	Acres treated
Zineb	unknown
Other	Not investigated

1/ includes multiple applications

E. ECONOMIC IMPACTS:

User: As pesticide users substitute other available pesticides, cost savings of approximately $776,000 should result. Because usage of zineb is low relative to amounts of other pesticides used on citrus, it is not likely that the small increase in demand for other pesticides resulting from cancellation of zineb will significantly increase prices of those substitutes.

Market: With the impact of the cancellation of zineb likely to be negligible the overall market will not be significantly affected.

Consumer: Negligible.

F. SOCIAL/COMMUNITY IMPACTS: No significant impact anticipated.

G. LIMITATIONS OF ANALYSIS

1. Available cost and application rate data not always consistent.
2. Assumption that growers needing rust mite controls would use a miticide intended for that purpose, rather than zineb.
3. Data illustrating amount of zineb actually used for miticidal purposes not available.

PRINCIPAL ANALYST: Elena Salitto -Economic Analysis Branch - Criteria and Evaluation Division - Office of Pesticide Programs
January, 1979. U.S. EPA

III. BENEFIT ANALYSIS OF ZINEB USE ON CITRUS

CURRENT USE ANALYSIS

EPA Registrations of Zineb and Alternatives

Zineb is currently registered to control citrus rust mites and greasy spot disease, pests common to citrus growers in Florida and Texas (limited greasy spot infections occur in California). A large number of alternative miticides are also EPA registered to control rust mites, and several fungicides are registered against greasy spot. A tabular summary of the pesticides having coincident registrations with zineb are presented in Table I-43.

Recommendations for Use of Zineb and Alternatives

<u>State Recommendations</u>

Because the climate in Arizona is so dry, neither greasy spot nor citrus rust mites can thrive and damage crops. Greasy spot disease is virtually unknown in the state, and the last attack of citrus rust mites occurred approximately 10 years ago, with only slight infestation[1/]. For these reasons, further study of Arizona is excluded from this analysis.

Zineb is no longer recommended as either a miticide for controlling rust mites or as a fungicide against greasy spot in either Texas or Florida, the states most affected by these pests. Other fungicides have greater residual efficacy than zineb in these states and hence are more valuable to growers.

Greasy spot disease is not a common problem to citrus growers in Calfornia. Where fungicides are needed, usage is confined to one of the non-EBDC types. Therefore, pertinent pesticide recommendations for California are limited to miticides to control citrus rust mites. State recommendations for California, Texas, and Florida are as follows, taken from a detailed summary presented in Table I-44.

1/ Drs. Donald Tuttle and Joseph Troutman, plant pathologists at the University of Arizona Agricultural Extension Service, personal communication, July 25, 1978.

Table I-43

EPA Registered Controls for Rust Mite and Greasy Spot on Citrus[a/]

Pesticide	Rust Mite	Greasy Spot
aromatic petroleum derivative solvent	G,L,M,O,N,A	
aromatic petroleum distillate, oil, solvent or hydrocarbons	M,A	
basic copper sulfate		G,L,O,N,A
benomyl		G,O,L,M,A,N,K
1,1-bis(chlorophenyl)-2,2,2-trichloroethenol	G,L,M,O,N	
carbaryl	L,A	
carbophenothion	L,G,O,N,A,M	
cyhexatin	L,G,O,M,A	
chlorobenzilate	L,O,G,M,A,N,K	
copper		G,L,O,N,A
dialifor	G,O,N	
O,O-dimethyl s-phosphorodithiate	L,A	
dioxathion	L,M,A	
ethion	G,O,N,A	
ethyl 4,4-dichlorobenzilate	G,O,N	
folpet	L,A	
malathion	L,O,G,M,A,N,K	
petroleum distillate, oils, solvent, or hydrocarbons: also paraffinic hydrocarbons, aliphatic hydrocarons, paraffinic oil	L,O,G,M,A,N	L,O,G,M,A,N,K
piperonyl butoxide	L,A	
pyrethrins	L,A	
rotenone	L,A	
sulfur	G,L,M,O,A,N,K	K
xylene range aromatic solvent	L,O,G,M,A,N	
zineb	L,O,G,M,A,N,K,	L,O,G,M,A,N,K

a/ Key: L = lemons; O = oranges; G = grapefruit; M = limes; A = tangerines; N = tangelos; K = kumquats

Source: Site/Pest/Chemical Registration Information, EPA, Oct. 1976.

Miticides

azinphosmethyl (Guthion)
carbophenothion (Trithion)
chlorobenzilate (Acaraben)
cyhexatin (Plictran)
dicofol (Kelthane)
dioxathion (Delnav)
ethion
fenbutatin-oxide (Vendex)
formetanate hydrochloride (Carzol)
propargite (Comite)
sulfur

Fungicide (Florida and Texas only)

benomyl (Benlate)
copper
oil

Tabular summaries of the state recommendations for citrus rust mites and for greasy spot control are found in Appendix A.

Federal Guidelines

Zineb is not among those miticides included in the USDA guidelines for citrus rust mites. Materials included in the Federal guidelines are as follows:

azinphosmethyl (Guthion)
carbophenothion (Trithion)
chlorobenzilate (Acaraben)
dicofol (Kelthane)
dioxathion (Delnav)
sulfur
Torak (dialifor)

At present, zineb is the only USDA recommended fungicide for control of greasy spot disease. This listing of recommended fungicides is currently being revised, and it is expected that benomyl (Benlate) will be added to the revised edition. A tabular summary of USDA miticide guidelines for citrus rust mites can be found in Appendix B.

Use of Zineb and Alternatives

Although the use of zineb has been declining since 1971, it remains an important fungicide in certain areas for the control of pests on citrus. Zineb is most significant in Texas; it is used either alone or combined with oil on over 50% of the fungicide treated citrus acreage. A summary of available fungicide usage data on grapefruit and oranges (Texas' principal citrus crops) is presented in Table I-45.

A total of 33,000 or 55% of the 60,000 acres treated with fungicides were treated with some form of zineb. At a minimum application rate of 7.5 lb./acre[1], a total of 247,500 lbs. of zineb were used in Texas in 1975 (Table I-46). Kocide also had significant usage in Texas; approximately 52,500 lbs. of this

Table I-44

Summary of State and Federal Recommendations for Citrus Rust Mites Control and Greasy Spot Control on Citrus Crops

	California	Florida	Texas	USDA
Miticide - Rust Mite				
azinphosmethyl (Guthion)		x	x	x
carbophenothion (Trithion)		x	x	x
Carzol (formetanate hydrochloride)		x	x	
chlorobenzilate (Acaraben)	x	x	x	x
dicofol (Kelthane)		x	x	x
dioxathion (Delnav)		x	x	x
ethion		x	x	x
fenbutatin-oxide (Vendex)		x	x	
Plictran (cyhexatin)		x		
propargite (Comite)		x	x	
sulfur	x	x	x	x
torak (dialifor)		x		x
Fungicide - Greasy Spot				
copper		x	x	
benomyl (Benlate)		x		*
oil		x	x	x
zineb				

* At present zineb is the only USDA recommended fungicide for use against greasy spot. This list is currently being revised, and is expected that benomyl will be added to the new listing.

Source: Treatment guide for California Citrus Crops, 1976-1978, University of California, Division of Agricultural Sciences. Florida Citrus Spray and Dust Schedule, 1977, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Texas Guide for Controlling Insects and Pests, 1978. Texas Agricultural Extension Service, The Texas A&M University System. USDA Insecticide Recommendations, 1974.

fungicide were applied in 1975. Poundage figures for the miscellaneous combinations and chemicals were omitted since usage levels were too imprecise for estimation. While more recent usage estimates are not available, it is believed that growers have been drifting away from zineb and substituting other fungicides that have longer residual efficacy, hence making them more useful to control this long term disease. Oil and supracide have been found to be very good greasy spot controls in Texas[2].

A small number of Texas growers (5%) reported using zineb to control scab[3] in 1975. Further information was not available but the amount used for this purpose is believed to be negligible.

1/ FMC Corp. recommended poundage: Benefit Analysis of EBDC Fungicides Use on Selected Crops., April, 1978.

2/ Dr. Herbert Dean, Entomologist, Texas Agricultural Experiment Station, Weslaco, Texas, Personal communication, July 21, 1978.

3/ Doane Survey, 1976.

Table I - 45

penditures, Total Treatment Acres, Growers Treating with Fungicides on Texas Citrus, 1975 estimated.

pe of Chemical	Expenditures		Total Treatments		Growers Treating	
	Dollars (000)	Percent	Acres (000)	Percent	Growers	Percent
neb	70	35	22	37	850	44
l/Zineb	32	16	11	18	525	27
:ide	26	13	7	12	225	12
ıer Misc. Chemicals	19	10	3	5	110	6
ıer Misc. Combinations	51	26	17	28	206	11
Total	198	150	60	100	1,916	100

ırce: Doane, 1976

Table I-46

ESTIMATED POUNDS FUNGICIDE ACTIVE INGREDIENT APPLIED TO TEXAS AND FLORIDA CITRUS[1/]

Pesticide	Acres Treated (000) Florida	Texas	Total	Application Rate/Acre	Subtotal, 1lbs. applied Florida	Texas	Total	%a.i.	Total lb. a.i. Florida	Texas	Total
zineb	46	33	79	7.5 - 10 lbs.	345,000 -460,000	247,000 -330,000	592,000 -790,000	75%	258,000 -345,000	185,625 -247,500	444,375 -592,500
benomyl	29		29	1.5 - 316.500 gals.	43,500 -87,000		43,500 -87,000	80%	34,800 -69,600		34,800 69,600
citcop	68		68	1.03 gals.	70,040		70,040				
copper A	21		21								
copper oxide	21		21								
copper sulfate	49		49	18.01 lb.	882,490		882,490	25.2%	222,387		222,387
kocide	102	7	109	7.5 lb.	765,000	52,500	817,500	46-47%	361,000 -359,550	24,150 -24,675	376,050 -384,225
nu-cop	266	266									
oil	692		692	10-15 gal.	6,920,000 -10,380,000		6,920,000 -10,380,000	100%			6,920,000 -10,380,000
tri-basic	22		22	8.41 lb.	184,800		184,000	56%	103,488		103,488
benlace/oil	196		196								
copper sulfate oil	238		238								

1/ Calculated by multiplying recommended application rates by acres treated
Source: Doane, 1976: FMC Corp. 1978, Florida Citrus Spray and Dust Schedule, 1977.
Texas Guide for Controlling Pests and Disease on Citrus, 1978.

Pest Infestation and Damage

Greasy spot is a defoliating and fruit blemishing fungal disease that attacks citrus both in Florida and in Texas. Its most serious effect is on the leaves of the tree, causing blistering, spotting, and premature leaf dropping. With severe infections, leaf droppage can be as high as 80 percent[1/], and fruit yield for the following year may be substantially lowered.

Greasy spot also affects fruit rind resulting in discoloration and blemishing. The effect of the disease on the fruit is superficial as it affects only the rind and has no effect on internal fruit quality. Its significance, therefore, is primarily on fruit intended for fresh market, where perfect fruit appearance is important. Due to its potential effect on the leaves of the trees, adequate control of this disease is essential to preserve the overall health of the grove.

For many years, greasy spot was considered to be a disease of minor importance to citrus growers. During the 1940's and 1950's, the disease apparently became increasingly severe, and is now considered serious enough to warrant routine control measures[2/].

1/ Handbood of Citrus Diseases in Florida: Bulletin 587, June 1957, p. 66, University of Florida Agricultural Experiment Station.

2/ Whiteside, J.O., "Greasy Spot of Citrus, A New Look at this Important Defoliating and Fruit Blemishing Fungal Disease," The Citrus Industry Feb. 1973.

The decline in the use of zineb as a greasy spot control has been most apparent in Florida. In 1971 it was estimated that approximately 1.1 million pounds of zineb were used on 179,000 acres of Florida citrus for pest control[1]. By 1976 usage had declined to an estimated 345,000-460,000 lbs. on 46,000 acres, a reduction of between 69-74%[2].

Florida growers use a wide variety of fungicides (Table I-47). The copper and oil fungicides are the most widely used. The various copper compounds were used on approximately 458,000 acres, 23% of the total treated acreage. Oils were utilized on 907,000 acres or 37% all treated acres. The 46,000 acres treated with zineb comprised only 1.9% of all acreage treated.

The EBDC fungicides are not utilized in California and hence, any discussion of California usage of fungicides in excluded from this portion of the study.

Zineb is sold for use as a fungicide. Its toxicity to rust mites is purely supplemental, and usage data of zineb as a miticide was unavailable. Table I-48, I-49 and I-50 are included to illustrate the extent of use of other miticides to control rust mites in Florida and Texas. Any use of zineb is likely to be supplemental to these miticides; that is, its use would be an additional control measure as opposed to a substitute for any of the miticides listed.

Chlorobenzilate and combinations including chlorobenzilate have the most widespread usage on Florida citrus of all miticides. Of the 21,079 Florida citrus growers using miticides, an estimated 8,076, or 38.6% used some form of chlorobenzilate to control rust mites in 1975. Chlorobenzilate was used on 637,000 acres, which represents 44.6% of the total 1,444,000 miticide treated citrus acreage.

Ethion is also widely used on Florida citrus. In 1975 approximately 20% of the citrus growers used ethion on 14.6% of all treated acreage.

Chlorobenzilate is also the most widely used miticide on Texas citrus, with the next principal miticide used being carbophenothion.

Chlorobenzilate and chlorobenzilate combinations were used by an estimated 52% of Texas citrus growers on 46.4% of the 125,000 treated acres. Carbophenothion or carbophenothion combinations were used on 37.6% of the treated citrus acreage by 19% of the 4,527 citrus growers in Texas. The remaining 20,000 acres were treated with oil, sulfur, ethion, and dicofol combinations.

1/ Internal Review of EBDC Fungicides and Their Residues, Criteria and Evaluation Division, OPP, EPA. February, 1975.

2/ Ibid.

[illegible] the use of [illegible]

[illegible] million [illegible] of [illegible] were [illegible]
[illegible] citrus [illegible] control [illegible]
[illegible] estimated [illegible],000-[illegible],000 lbs. [illegible]
[illegible] of between [illegible]

Growers use a wide variety of fungicides. [illegible]
copper and oil [illegible]
copper compounds [illegible]
of the total [illegible] acreage [illegible]
[illegible] oil [illegible]
[illegible] and only 1.[illegible] of all acreage [illegible]

[illegible] fungicides [illegible] not utilized [illegible]
[illegible] of California [illegible] fungicides
[illegible] of the [illegible]

[illegible] is sold for use as a fungicide [illegible]
[illegible] purely supplemental. [illegible]
[illegible] as a fungicide. Table [illegible]
[illegible] the extent of use [illegible]
[illegible] Florida and Texas. [illegible]
[illegible] to these miticides [illegible]
[illegible] control measure [illegible]
[illegible] listed.

[illegible] benzilate [illegible] insecticide [illegible]
[illegible] widespread usage [illegible] Florida [illegible] of all [illegible]
[illegible] Florida [illegible]
[illegible] 38.6% used [illegible]
[illegible] 1973. Chlorobenzilate [illegible],000 acres [illegible]
[illegible] 6% of [illegible] 1,[illegible],000 [illegible]

[illegible] is also widely used on Florida citrus [illegible]
[illegible] 20% of the citrus growers [illegible]

[illegible] is also the [illegible] widely used miticide [illegible]
[illegible], with the most principal miticide [illegible]

[illegible] and chlorobenzilate [illegible] were used by
[illegible] of Texas citrus growers [illegible]
[illegible] or carbophenothion [illegible]
[illegible] of the treated citrus acreage [illegible]
[illegible] The remaining [illegible] acres [illegible]
[illegible] sulfur, [illegible] chemical combinations.

[illegible] and Their Metabolites.
[illegible] February, 197[illegible].

Table I-47

Expenditures, Total Treatments and Growers Treating with Fungicides, on Florida Citrus, Estimated for 1975

Type of Chemicals	Expenditures Dollars (000)	Expenditures Percent	Total Treatments Acres (000)	Total Treatments Percent	Growers Treating Growers	Growers Treating Percent
Benlate	191	1	29	1	231	1
Citcop	385	2	68	3	800	5
Copper-A	71	.4	21	1	683	4
Copper Oxide	139	1	21	1	803	5
Copper Sulfate	459	2	49	2	939	6
Kocide	681	3	102	4	1,179	7
Nu-Cop	942	4	266	11	3,938	23
Oil	13,563	70	692	28	6,200	37
Tri-basic	167	1	22	1	675	4
Benlate/Oil	1,428	7	196	8	340	2
Copper/Sulfate/Oil	238	1	19	1	494	3
Other Misc. Chemicals	1,158	6	942	38	280	2
Other Misc. Combinations	88	.6	28	1	196	1
TOTAL	19,510	100	2,456	100	16,758	100

Source: Doane, 1976.

Table I-48

Number of Growers Mentioning Rust Mite Problems and Specific Chemicals for Control, as Estimated for 1975

Chemical	Florida growers	Florida percent	Texas growers	Texas percent
Acarben (chlorobenzilate)	6,066	29	992	22
Ethion	1,108	5	165	4
Kelthane	594	3	—	—
Oil	311	1	311	7
Sulfur	6,546	31	84	2
Trithion	355	2	421	9
Delnex-8	425	2	—	—
Acaraben/Arsentate	486	2	—	—
Acaraben/Guthion	219	1	136	3
Acaraben/Sulfur	393	2	332	7
Carzol/Oil	143	.7	—	—
Ethion/Sulfur	77	.4	—	—
Ethion/Oil	3,194	15	752	17
Karathene/Oil	77	.4	—	—
Kelthene/Oil	96	.5	112	2
Kelthene/Sulfur	77	.4	—	—
Oil/Trithion	—	—	287	6
Acaraben/Sulfur/Malathion	118	.6	—	—
TOTAL	21,079	100	4,527	100

Source: Doane, 1976.

Table I-49

Expenditure, Average Expenditure per Acre Treatment and Acres Treated with Miticides for Florida Citrus, Estimated for 1975

Chemical	Expenditures: Expenditure (000)	Expenditures: Percent	Average Expenditure/Acre Treatment dollars	Acres Treated: Acres (000)	Acres Treated: Percent
Acaraben (chlorobenzilate)	2,824	37	6.50	435	30
Ethion	512	7	11.38	45	3
Kelthane (Dicofol)	135	2	10.38	13	.9
Oil	124	2	4.43	28	2
Sulfur	1,193	16	2.34	509	35
Trithion	131	2	10.91	12	.8
Delnex-8	212	3	12.47	17	1.2
Acaraben/Arsenate	33	.4	4.71	7	.5
Acaraben/Oil	473	6	5.91	80	6
Acaraben/Sulfur	408	5	3.61	113	8
Ethion/Oil	1,458	19	8.78	166	11.5
Ethion/Sulfur	10	.1	10.00	1	.07
Kelthane/Oil	70	.9	4.67	15	1
Kelthane/Sulfur	23	.3	23.00	1	.07
Acaraben/Sulfur/Malathion	12	.2	6.00	2	.1
TOTAL	7,618	100		1,444	100

Source: Doane, 1976.

Table I-50

Expenditures, Average Expenditure per Acre Treatment, and Acres Treated with Miticides for Texas Citrus, Estimated for 1975

Chemical	Expenditure		Expenditure/Acre Treatment	Acres Treated	
	Expenditure (000)	Percent	dollars	acres (000)	Percent
Aracaraben (chlorobenzilate)	290	40	8.79	33	26.4
Ethion	8	1	4.00	2	1.6
Oil	46	6	5.75	8	6.4
Sulfur	6	.8	1.50	4	3.2
Trithion (carbophenothion)	54	7	3.00	18	14.4
Acaraben/Oil	130	18	15.00	15	12
Acaraben/Guthion	31	4	3.10	10	8
Ethion/Oil	34	5	11.34	3	2.4
Kelthane/Oil (Dicofol)	55	7	18.34	3	2.4
Oil/Trithion	80	11	2.76	29	23.2
TOTAL	732	100		125	100

Source: Doane, 1976.

Miticide usage to control citrus pests in both Florida and in Texas is widespread. Growers use a variety of chemicals, many of which offer good control of citrus rust mites as well as other mites that prey on the groves. Cancellation of zineb, whose toxicity is peculiar to rust mites only, is not likely to greatly affect usage of the variety of miticides available offering multiple control of a number of mites. Many of these miticides are part of the routine spray schedule to control all mites, and discontinued use of zineb is not likely to have any effect on the ability to control rust mites using the other miticides.

Citrus rust mites feed on leaves, fruit and green twigs. Their presence may result in premature leaf drop, and often causes "russetting" (brown discoloration) of the fruit.

The citrus rust mite is considered the principal pest of oranges and grapefruit in Texas, and among the most important of the pests of those fruits in Florida[1/]. Protection of groves from the citrus rust mites is mandatory for the preservation of overall tree health and vitality of the grove.

Comparative Performance Evaluation

Comparative Efficacy

Although zineb was at one time considered an effective agent against both greasy spot disease and citrus rust mites, its use is no longer recommended by citrus producing states. Its effectiveness has declined through the years, and at present is questionable. There are currently five methods for controlling greasy spot disease:

1. Removing leaf litter from the grove floor so as not to provide the medium for the growth of the disease innoculum.

2. Benomyl (Benlate)

3. Copper Fungicides

4. Oil

5. Zineb

1/ Ebeleing, Walter, "Citrus Pests in the United States," University of California, 1959.

Any combination of methods can be used to provide optimal control. The removal of leaf litter, which is a fertile area for the fungus to grow, can provide good control to the farmer. It is likely that many growers would also spray as an additional precaution. This combination should provide good control as removal of leaf litter would reduce the possibilities of massive infestations requiring extreme curative measures. The major drawback of the leaf removal method is prohibitive labor costs involved in an effective clean up and disposal.

Copper fungicides have long given the most effective control of greasy spot. There are, however, many serious problems associated with the use of the copper fungicides. Copper tends to darken already existing lesions on the fruit which may negate the possibilities of it being sent to the fresh market. However, if there are few lesions (as is often the case) the fruit will be essentially unaffected. A more serious problem associated with copper is that prolonged use may lead to accumulations of toxic concentrations in the soil. This is most true in areas of high usage with acid soils[1/]. Despite its effectiveness, the drawbacks associated with copper make it, at best, a possibly useful but not ideal control.

Oil is also recommended for greasy spot control but is less effective than copper. In addition, the timing of the oil application is very important. Use while the weather is hot with low humidity may induce fruit burning, severely damaging the crop[2/].

Benomyl has been found to give as effective control as copper, without the immediate side effects. The major problem associated with benomyl is that it is an RPAR chemical; thus, its future registration status is uncertain.

The use of zineb as a fungicide has declined significantly and as a control for greasy spot, has been characterized as unreliable [3/]. In addition, it does not have the residual efficacy of benomyl, copper or oil, which is necessary for adequate control of this long term disease. Finally, when zineb is mixed with oil, as in common practice, it is the oil, rather than the zineb which gives the control, thus masking the efficacy of zineb[4/].

1/ "Greasy Spot of Citrus - A New Look at This Important Deoliating and Fruit Blemishing Fungal Disease." J.O. Whiteside, The Citrus Industry. Feb. 1973, p.27

2/ Mr. H. Dean, Texas A&M University, Personal Communication. July 16, 1978.

3/ Ibid.

4/ J.O. Whiteside, Personal Communication. Nov. 27, 1974.

Table I-51

Comparison of Spray Materials for the Control of Greasy Spot

	Rate per 100 gal	Percentage leaf acre diseased — Test number 1	2	3	4	5	6	7	8	9	10
Control, not sprayed	—	6.9 c[c]	11.6 c	14.5 c	15.9 b	23.6 d	19.5 d	15.3 d	30.6 c	12.6 d	14.2 d	
tribasic copper sulfate 53% Cu	3.0 lb	0.4 a	—	—	—	—	—	—	—	—	—	
do.	1.5 lb	—	0.9 a	0.9 a	4.2 a	2.6 a	1.9 a	4.1 b	0.7 a	0.1 a	—	
do.	0.75 lb	—	—	—	—	—	4.6 ab	—	2.6 a	—	—	
C-C N 0.3 lb Cu per gal	0.5 gal	—	—	—	—	—	3.7 ab	—	1.0 ab	—	—	
do.	0.33	—	—	—	—	—	5.7 b	—	—	—	—	
K 101 54% Cu	0.75	—	—	—	—	—	3.2 ab	—	1.1 ab	—	—	
copper salts of fatty and resin acids 0.32 lb Cu per gal	1.0 gal	—	—	—	—	—	2.7 ab	—	—	—	—	
do.	0.5 gal	—	—	—	—	—	—	—	2.0 ab	—	—	
do.	0.25 gal	—	—	—	—	—	—	—	2.6 b	—	—	
zineb 75 W	2.0 lb	4.7 bc	4.7 b	1.4 a	—	—	—	14.3 d	—	—	—	
do.	1.0 lb	—	—	—	—	14.3 cd	15.5 d	—	—	—	—	
zinc + maneb	1.0 lb	—	—	—	—	—	—	—	—	4.0 c	2.8 b	
oil (FC 435-66 specifications)	1.3 gal	1.3 ab	2.6 ab	7.1 b	5.8 a	8.7 bc	10.2 c	6.1 bc	—	—	—	
do.	0.65 gal	—	—	—	—	—	—	9.0 c	—	—	—	
benomyl 50 W	1.0	0.9 a	1.1 ab	—	—	—	—	1.7 a	—	—	—	
do.	0.5 lb	—	—	0.1 a	—	2.7 a	4.3 ab	1.5 a	—	—	0.3 a	
benomyl 50 W:oil	0.5 lb:0.65 gal	—	—	—	—	—	—	0.6 a	—	—	—	
do.	0.25 lb:0.5 gal	—	—	—	—	—	—	—	1.1 ab	0.1 a	—	
thiophanate-methyl 70 W	0.75 lb	—	—	—	—	—	—	—	—	0.3 ab	0.3 a	
thiabendazole 60 W	1.0 lb	7.8 c	—	—	—	—	—	—	—	—	—	
Poly. 80 W	1.0 lb	—	—	—	—	—	—	—	—	7.4 c	6.2 c	
dithianon 75 W	1.0 lb	—	—	—	—	—	—	—	—	1.1 b	11.2 d	
chlorothalonil 6 F	0.17 gal	—	—	—	—	—	—	—	—	0.6 a	1.9 b	
dichlozoline 60 W	1.0 lb	—	—	—	18.0 b	18.9 d	—	—	—	—	—	
Lin. 60 W	1.0 lb	1.5 ab	—	—	—	—	—	—	—	—	—	
Lfn. 4 F	0.25 gal	—	3.6 ab	0.1 a	—	3.4 ab	—	—	—	0.1 a	—	
hexachlorophene	0.625 gal	—	—	—	15.3 b	18.1 d	—	—	—	—	—	
C W-524 20 EC	0.125 gal	—	—	—	—	—	—	—	—	4.1 c	6.6 c	
triarimol 4.5 EC	0.1 gal	—	—	17.2 c	—	—	—	—	—	—	—	

a Amount of formulated product.
b See Table 1 for information on varieties of citrus used, and on the dates of spraying and disease recording in each test.
c Values within a column followed by a common letter do not differ significantly at the 5% level, according to Duncan's Multiple Range Text. Analysis of variance was made on the equivalent angles after angular transformation of the percentages.

Source: Whiteside, J.C. "Evaluation of Spray Materials for the Control of Greasy Spot of Citrus", Plant Disease Reporter, Vol. 57, No. 8, August, 1973.

Miticides

The advantage of using zineb over other fungicides is its supplemental toxicity to citrus rust mites. However, though it was once an effective control against the mites, some plant pathologists have found that mites have developed a resistance to zineb and that it is no longer effective[1]. A number of miticides are available for the control of rust mites. Unlike zineb, these miticides are effective controls against other species of mites, and it is likely that growers will use them as an integral part of their standard spray program to control pests.

Chlorobenzilate, for example, is recommended as a good control against rust mites, bud mites, red mites and a number of others. In addition, because it is specifically a miticide, chlorobenzilate does not seriously disrupt the predators and parasites of other citrus pests. It is estimated that 80% of the citrus growers in Florida presently use Chlorobenzilate at least once a year, and that well over half the growers in Texas use it to some extent.

Sulfur has for many years been the standard method of control and its use is still recommended by the citrus states. It is very effective for short period control; however it is gradually washed off the tree and produces an undesirable level of acidity in the soil. Continued use of sulfur has been followed by increases in spider mite and armored scale population, so its use should be alternated with one of the other available pesticides[2]. Other miticides that control rust mites and other species are ethion, carbophenothion, dioxathion, and dicofol.

Test Data

A number of tests have been performed to evaluate the efficacy of the various miticides. Zineb was included in only one test when it was compared to maneb; it is important to note that the experiment was conducted before any mite resistance to zineb was experienced.

In tests comparing chlorobenzilate and sulfur to control citrus rust mites on orange trees, a 4 percent chlorobenzilate dust applied at 100 pounds of formulation per acre was relatively ineffective compared to sulfur dust applied at the same rate. However, a chlorobenzilate 25% WP formulation applied as a spray at 4 pounds active ingredient per acre provided control as satisfactory as a sulfur spray at 30 pounds per acre, or a sulfur dust at 100 pounds per acre.

1/ J.O. Whiteside, Personal Communication. Nov. 27, 1974

2/ Louis W. and Herbert S. Wolfe. Citrus Growing in Florida. University Presses of Florida, Gainesville, 1975. p. 182-183.

Test performed during 1957 near Harlington, Texas by Dean (1959) evaluated a chlorobenzilate-sulfur combination, an aramite-sulfur combination, and sulfur for control of citrus rust mites and spider mites on grapefruit (Table I-52). Applications of all materials in June and September resulted in low levels of citrus rust mites (less than 1 mite per leaf for all treatment).

In recent tests conducted by Dean (1974) in Texas, several compounds were evaluated for control of citrus rust mites in plots of orange trees. Chlorobenzilate was utilized twice during the test periods. In December 1971, chlorobenzilate was applied to a plot following a control failure. On November 2, 1973, chlorobenzialte, ethion and a combination of propargite and wetting agent were applied to the plot areas. The results indicated that citrus rust mites were more effectively controlled by ethion and chlorobenzilate than by propargite. Seventy days after treatment with ethion, chlorobenzilate and propargite there were 0.1 and 18 citrus rust mites per 80 leaf sample, respectively.

Table I-52

Populations of Eutetrancychus Banksi McG. Mites and Eggs and Citrus Rust Mites in Miticide (dust) Tests Conducted at the Crockett Grove Near Harlingen, Texas During 1957

Date	Sulfur[1]			3% Chlorobenzilate-Sulfur[1]			3% Aramite-sulfur[1]		
	MPL[2]	EPL[2]	RML[2]	MPL	EPL	RMPL	MPL	EPL	RMPL
6-4	18.3	18.9	18.0	5.0	3.9	.8	6.3	5.4	25.9
6-8[3]									
6-24	2.8	1.7	.9	1.2	1.4	.3	.8	.4	.8
7-18	.8	.3	.1	11.2	1.4	.01	.2	.1	.1
8-1	.6	.9	.02	2.2	3.2	.02	.8	.8	.02
8-19	.8	1.0	.1	4.3	4.7	.03	1.2	1.0	.1
9-4	11.4	1.4	.1	9.2	9.0	.1	2.6	2.6	.1
9-18	3.3	3.6	.1	10.3	13.0	.6	9.2	14.1	.1
9-20[4]									
10-21	10.9	24.0	.03	27.7	29.0	.02	14.2	33.0	.1
11-25	3.4	3.8	.1	.4	.5	.03	3.1	4.0	.04

1 93% dusting sulphur, 3% Chlorobenzilate (52% sulphur in 1st application, 42 % sulphur in 2nd application, and 3% Aramite-sulphur).

2 MPL, E. banski mites per leaf; EPL, E. banski eggs per leaf; RMPL, citrus rust mites per leaf.

3 .65, .8, and .6 pound per tree of each material, respectively.

4 .75, .7, and .8 pound per tree of each material, respectively. On 6-18-75, 4-6" rain; on 9-2257, 2-3" rain.

Source: Dean, 1959.

Bailey and Dean (1962) evaluated zineb and maneb for citrus rust mite control in Texas during the period 1059-1961. Other compounds (tetradifon, dicofol) were added to zineb or maneb for control of false spider mites and Texas citrus mites. Different combinatory treatments of zineb and maneb provided good control (28 or fewer rust mites per 160-leaf sample) after extended periods (September 1959 to April 1960 and September 1960 to February 1961). Table I-53 summarizes the results of these field tests. However, since mite resistance to zineb has developed subsequent to these tests, the above results may no longer be a fair indication of the efficacy of zineb as a mite control.

Comparative Yield/Quality

An evaluation of yield and quality comparisons between zineb and its alternatives is not included in the analysis because of data limitations.

It is recognized that the loss of adequate pesticides to control rust mites and/or greasy spot disease would lead to a reduction in yield and fruit quality. However, such results seem unlikely if zineb were removed from the market.

Zineb is unreliable for control of greasy spot. Removal of the pesticide from the market would mean substitution with one of the more effective fungicides. Benomyl appears to be a particularly excellent fungicide, giving good control without harmful side effects.

Growers must be able to adequately control more than just the citrus rust mite. To do this, miticides toxic to several species of mites including the citrus rust mite are used. In view of this, it would appear that depending on zineb as a rust mite control would simple be duplicating toxic control effects of other miticides already being used. Thus to remove zineb from the market will have virtually no effect on rust mite control.

Table I-53

Spray Treatments Applied in a Substation No. 15 Grove and Their Effect on Citrus Rust Mites, Texas Citrus Mites, and False Spider Mites

Date	Zineb plus Tedion or Kelthane[1]					Maneb plus Tedion or Kelthane[1]				
	RM[2]	TCM[3]	TCME[4]	FSM[5]	FSME[6]	RM[2]	TCM[3]	TCME[4]	FSM[5]	FSME[6]
4- 7-59	32	—	—	—	—	22	2	—	—	—
4-29-59	46	—	—	—	—	56	—	—	—	—
5- 6-59	Zineb - Tedion					Maneb - Tedion				
5-25-59	—	—	—	—	—	—	—	—	—	—
6-26-59	—	—	12	—	—	6	4	—	—	—
7-28-59	40	10	16	—	—	14	6	2	2	—
8-18-59	92	44	66	—	—	180	42	48	10	—
8-20-59	Zineb - Kelthane					Maneb - Kelthane				
9-14-59	8	—	—	—	—	—	—	—	—	—
11-11-59	4	—	—	—	—	—	4	4	—	—
12-16-59	8	2	4	—	—	4	—	—	—	—
1- 4-60	6	—	—	—	—	12	—	—	4	—
2-11-60	10	—	2	—	—	8	—	—	—	—
3- 9-60	6	4	8	—	—	28	2	6	—	—
4-11-60	12	4	4	—	—	24	—	—	—	—
4-19-60	Zineb - Tedion					Maneb - Tedion				
5-25-60	—	—	2	—	—	6	2	4	—	—
6-17-60	—	—	—	—	—	2	—	—	—	—
7-25-60	4	2	6	6	4	42	6	8	2	—
8-17-60	36	28	30	—	—	34	44	10	4	—
8-24-60	Zineb - Kelthane					Maneb - Kelthane				
9-16-60	—	—	—	—	—	2	—	2	—	2
10-18-60	—	—	—	—	—	—	2	—	—	—
11-15-60	6	—	—	—	4	—	—	—	—	—
12-16-60	10	—	—	—	—	10	—	—	—	—
1-23-61	8	—	—	—	—	10	—	2	—	—
2-20-61	8	2	—	—	4	16	2	6	2	2
3-30-61	176	2	2	—	—	208	—	—	—	—
4-17-61	Zineb - Tedion					Maneb - Tedion				

Date	Zineb plus Tedion or Kelthane[1] RM[2]	TCM[3]	TCME[4]	FSM[5]	FSME[6]	Maneb plus Tedion or Kelthane[1] RM[2]	TCM[3]	TCME[4]	FSM[5]	FSME[6]
5-18-61	—	8	4	—	8	—	—	—	—	—
6- 8-61	6	—	8	—	4	—	—	—	—	—
7-14-61	—	—	14	8	6	2	2	2	—	2
8- 3-61	—	—	2	—	2	—	8	2	—	—

1 Dosages of the following materials per 100 gallons of mixture: 1 lb. 75% WP zineb, 1 lb. 80% WP maneb, 1 lb. 25% WP Tedion and 1 quart 18.5% EC Kelthane, Triton B-1956 was added to each maxture at the 2 ounce rate.

2 Citrus rust mites on 160 leaves.

3 Texas citrus mites on 160 leaves.

4 Texas citrus mite eggs on 160 leaves.

5 False spider mites on 160 leaves

6 False spider mite eggs on 160 leaves

Source: Bailey and Dean, 1962.

Comparative Costs

A comparison of per acre treatment costs of zineb and three other fungicides (benomyl, copper, and oil) is presented in Table I-54. Of the four, zineb is most costly and time consuming to apply, requiring 2 applications with a total acre treatment cost of $19.94. The alternatives fungicides range in cost from 4.80 per acre-treatment to $17.43. The average cost of the alternative pesticides is $14.16; $5.78 less than the average cost of zineb. Per acre treatment costs of various miticides are presented in Table I-55. Should a grower have problems with mites, it is likely he will use one of the miticides listed, rather than utilize zineb for mite control.

Miticide costs range from $2.67 to $30.00, with an average $15.01 per acre treatment expenditure for all listed pesticides. This figure could be compared with the $19.94 per acre treatment cost of using zineb. The average cost difference between the two types of treatment is $4.93 per acre treatment. (These calculations are for comparative purposes only and do not reflect the method of analysis used to derive the change in pesticide costs associated with the potential cancellation of zineb).

[illegible] per acre [illegible]
[illegible] (bentonal), copper, [illegible]
the four, zinc [illegible] most costly [illegible]
[illegible], requiring [illegible] applications [illegible]
of $10.95. The alternatives [illegible]
[illegible] per acre-treatment to [illegible] 17.43. The average [illegible]
[illegible] tive pesticides is $12.16; [illegible]
of zinc. Per acre treatment costs [illegible]
presented in [illegible] 1-75. [illegible]
[illegible] areas, it [illegible] likely [illegible]
[illegible] than utilize zineb for [illegible] control.

[illegible] costs range from $2.5 [illegible] to $30.[illegible]
[illegible] acre [illegible] expenditure for [illegible]
[illegible] could be [illegible] with the $11 [illegible]
zineb. The average co [illegible] differs.
[illegible] treatment is $8.9 [illegible]
are for comparative purposes only [illegible]
analysis used to derive [illegible]
ated with the possibility of [illegible]

Table I-54

Comparison of Per Acre Treatment Costs using Zineb and Major Alternatives for Control of Greasy Spot. Estimated for 1977

Fungicide	Cost/Unit	Application Rate/Acre	Application Cost/Acre Low -- High	Number of Applications	Total Fungicide Cost/Acre
Zineb	$1.33/lb.	7.5	$ 9.97	2	$19.94
Benomyl	$7.75/lb.	1.5 - 3.0 lb.	$11.62 - $23.25	1	$17.43
Copper	$ .91/lb.	3.5 - 7.0 lb.	$ 3.18 - $ 6.37	1	$ 4.80
Oil	$1.37/lb.	7.5	$10.30	1	$10.30

Source: FMC Corporation, 1978.

Table I-55

Comparison of Pesticide Costs of Chlorobenzilate and Alternatives for Control of Mites on Citrus

Pesticide*	Expenditures Per Acre-Treatment ranges[a/]	average
Chlorobenzilate	5.71 - 17.50	11.61
Chlorobenzilate/arsenate	4.71	4.71
Chlorobenzilate/azinphosmethyl	2.67 - 17.91	10.29
Chlorobenzilate/methidathion	13.00	13.00
Chlorobenzilate/oil	5.43 - 17.81	11.62
Chlorobenzilate/sulfur	3.50 - 7.67	5.59
Chlorobenzilate/sulfur/malathion	6.00	6.00
Carbophenothion	8.78	8.78
Dicofol	8.50 - 18.35	13.43
Ethion	11.05 - 15.70	13.38
Fenbutatin-oxide	30.00	30.00
Oil	4.43 - 19.59	12.01
Propargite	17.00	17.00
Sulfur	2.00 - 3.33	2.67
Carbophenothion/oil	14.78	14.78
Dicofol/oil	18.33	18.33
Dicofol/sulfur	23.00	23.00
Ethion/oil	8.41 - 25.00	16.71
Ethion/sulfur	10.00	10.00

a/ Expenditures per acre-treatment fall into a range due to variations in pesticide prices and differences in amounts applied per acre-treatment.

Source: Doane, 1976 Tex-Ag Company, 1975
Dean, 1976 Bullock, 1976

ECONOMIC IMPACT ANALYSIS

Profile of Impacted Areas

Citrus is one of the most important fruit crops grown in the U.S. In 1975, average per capital consumption of fresh citrus in the U.S. accounted for 35.2 percent (28.9 pounds) of total per capita consumption of fresh fruit (82 pounds) (U.S. Department of Agriculture, 1976a).

In 1973-74, the value of oranges, grapefruit, lemons, limes, tangerines, tangelos and temples produced in the U.S. was approximately 925 million (U.S. Department of Agriculture, 1975). The United States is the world's largest producer of citrus, accounting for 34.8 percent (13.1 million metric tons) of the 37.6 million metric-tons of citrus produced in the 23 leading countries (U.S. Department of Agriculture, 1976c). Domestic production of oranges, grapefruit, lemons, limes, tangerines, tangelos, and temples combined has increased from 150.4 million boxes in 1963-64 to 314.0 million boxes in 1973-74, an increase of 109 percent during this period (U.S. Department of Agriculture, 1975).

A total of 1,322 million acres of citrus crops (bearing and non-bearing) exists in the U.S., with the majority located in four states: Arizona, California, Florida and Texas. Total grower numbers of all citrus crops are undetermined; however, Doane (Doane; 1976) reported 26,340 U.S. Growers of lemons, oranges and grapefruit combined.

Profitable production of citrus crops is dependent upon numerous factors other than pesticides. Factors such as weather, the market price of citrus crops, prices of other inputs (e.g., land, labor, fertilizer) and competition from foreigh markets have major impacts upon citrus production costs and returns. Pesticides, an important input for citrus production, constitute about one-fourth of total annual variable production costs in many cases. For example, the combined cost of chemical control of insects, diseases and weeds for California lemons represented 22.5 percent of on-tree cash costs (does not include management, interest on investment or depreciation) in 1975 (Burns, 1975). In Florida, the combined cost of chemical control of insects and weeds for valencia oranges represented 27.1 percent of production costs in 1974-75 (Anderson and Muraro, 1975a).

User Impacts

An estimated 707,000 lbs. active ingredient of zineb were used on 79,000 acres of citrus in 1975-1976. At an estimated $19.94 total application rate per acre[1], zineb cost citrus growers $1,575.260. Cancellation of zineb would lead to growers substitution of lower cost alternative fungicides and a resulting cost savings.

Cost figures presented in Table I-56 were calculated by dividing expenditure for treatments by the number of acres treated, and using an average cost figure for oranges and grapefruit, the major citrus fruits on which zineb is used. While not exact, this method of calculation yields adequate approximations through which cost impacts can be assessed. Most of the data was obtained from the Doane survey, 1976. Cost or usage figures not available from Doane, were taken from estimates by FMC Corp. and the USDA/State/EPA Assessment Team for the usage of EBDC fungicides.

Although Florida growers used the greatest amount of zineb, they are the least likely to be significantly affected by the removal of zineb from the market. The 46,000 acres on which zineb was used represents a negligible amount of the total 1,476,000 fungicide treated acreage ion Florida. Similarly, the cost of zineb to citrus growers is less than 5% of the total expenditure on Florida fungicides[2].

Florida citrus growers use a large number of fungicides and it is likely that any increase in demand for substitute fungicides to zineb is likely to be distributed among the various fungicide brands. Hence, demand increases are likely to be small, and should not drastically affect prices of competing fungicides. Given present prices, cancellation of zineb will result in cost savings to the Florida growers of as much as $540,494.

1/ FMC Corp. Benefit Analysis of EBDC Fungicides Use on Selected Crops. April, 1978

2/ Doane survey, 1976

Table I-56

Expenditure per Acre Treatment, Acre Treatments, and Change in Cost for Fungicide Use in Florida, Texas, and Total U.S. Estimated for 1975

Pesticide Treatment	Florida			Texas			Total U.S.	
	Expenditure per acre-treatment	Acre-treatments	Costs	Expenditures per acre-treatment	Acre-treatments	Costs	Acre-treatments	Costs
Zineb	$19.94	46,000	$917,240	$19.94	33,000	$658,020	79,000	$1,575,260
TOTAL	19.94	46,000	917,240	19.94	33,000	658,020	79,000	1,575,260
Benomyl (Benlate)	17.43	3,833	66,809				3,833	66,809
Citcop	5.39	3,833	20,660				3,833	20,660
Copper Oxide	6.21	3,833	23,802				3,833	23,802
Copper Sulfate	8.35	3,833	32,006				3,833	32,006
Kocide	6.57	3,833	25,183				3,833	25,183
Nu-Cop	3.87	3,833	14,834				3,833	14,834
Oil	10.30	3,833	39,480				3,833	39,480
Tri-basic	7.50	3,833	28,748				3,833	28,748
Benlate/Oil	12.23	3,833	46,878				3,833	46,878
Copper/Sulfate/Sulfur	9.64	3,833	36,950				3,833	36,950
Other Misc. Chemicals	5.99	3,833	22,959	17.00	16,500	280,500	43,292	303,459
Other Misc. Combinations	4.81	3,833	18,347	4.30	16,500	141,900	43,292	160,337
TOTAL		46,000	376,746		33,000	422,400		799,146
Change in Pesticide Cost			$540,494			$235,620		-$ 776,114

The most significant impacts resulting from the cancellation of zineb will be in Texas. Zineb is used on a majority of the fungicide treated acreage by over half the Texas citrus growers. However, because Texas is one of the smaller producers of citrus, and their need for fungicides is low relative to Florida, any demand increase for substitute fungicides is not likely to significantly affect the total U.S. fungicide market.

Zineb represents a minute proportion of the more than $20 billion spent on fungicides by citrus growers in the U.S. Cancellation of zineb is not likely to have significant effects on costs of substitute fungicides, and is likely to result in fungicide cost savings of $776,114.

It is not expected that removing zineb from the market will have any effect on costs or supplies of miticides to growers.

Market Impacts

The 79,000 acres of citrus treated with Zineb in 1975 comprise only 5% of the orange and grapefruit acreage treated with fungicides in Florida and Texas[1/]. Because it is such a small percentage, it is not expected that cancellation of zineb would have any significant overall impact on the market. For those 79,000 acres, however, pesticide costs will be reduced as growers substitute lower cost fungicides, and yield per harvested acre may be higher due to usage of more effective greasy spot controls. The most significant impacts will be in Texas, where the largest percentage of growers use zineb; but as this figure is small relative to the country, the total U.S. market will not be greatly affected.

Consumer Impacts

Because usage of zineb is so low and its cancellation is not likely to markedly affect costs or production, consumer impacts, if any, will also be insignificant.

Social/Community Impacts

It is not anticipated that cancellation of zineb will have any significant social or community impacts. Production changes in any of the associated industries would not be so large as to have any effect on employment or income levels.

Macroeconomic Impacts

Due to the insignificant impacts projected in this analysis there appear to be no effects of importance on a macroeconomic level.

Limitations of Analysis

This analysis was performed under certain limitations in date and given the use of critical assumptions which further analysis may show to be inappropriate. These limitations include:

1. Available cost and application rate data for the various fungicides were not always consistent.

2. Data illustrating the amount of zineb used for rust mite control were unavailable.

3. The assumption that growers needing rust mite controls would use a miticide and the zineb was merely a supplemental measure.

APPENDICES

Appendix A

State Recommendations for Citrus,
Rust Mites and Greasy Spot

Zineb - State Recommendations - California

Site/Pest	Pesticide	Spray harvest interval	Formulation	Rate	Where & When to Apply	Safety Restrictions	Reference
Citrus Rust Mite	Zineb				Not recommended		Treatment guide for Calif. Citrus crop
Alternatives: Chlorobenzilate (acaraben)		0	EC	1.5 qt/acre	As needed - July through Sept. preferred.		1976 -1976
	Chlorobenzilate + Oil (Medium grade)		Emulsive	16-16 gal/100	As needed	Soil moisture should be at maximum before application. Discontinue when temperature reaches 95°F or humidity is less than 20%.	
	or Oil (narrow range 415)		Emulsive	1.2-1.4 gal/100	High dosage of narrow range only for July or Aug. application		
	Sulfur	1	WP	4 lbs./100 (at least 60 lbs./acre)	Oct. to Mar.15	Avoid application during or preceding high temperatures, do not apply within 2 months of an oil application.	

Zineb -State Recommendations Florida Home Garden (Dooryard)

Site/Pest	Pesticide	Spray harvest interval	Formulation	Rate	Where & When to Apply	Safety Restrictions	Reference
Citrus Rust Mite	Zineb				Not recommended		Insect Control Guide, Agricultural Extension Service, Institute of Food and Agricultural
	Alternatives: Chlorobenzilate				Thorough coverage of leaves and fruit is essential		Sciences, University of Florida, Gainesville, Sept. 1, 1975
	Dicofol (Kelthane)	7	18 1/2% EC	2 tsp/gal 1 pt/50 gal			
	Ethion	0	25% EC	2 tsp/gal 1 pt/50 gal		Do not repeat application within 90 days.	
	Ethion + Oil	0	25% EC 60-90% emulsion	1 pt/50 gal + 3 pts/50	2 applications not recommended (per year) but if applied do not re-apply for 6 weeks.	Do not apply during winter or when wilt signs appear. Do not mix with sulfur or apply within 3 weeks of sulfur application.	

Zineb - State Recommendations - Florida Commercial

Site/Pest	Pesticide	Spray harvest interval	Formulation	Rate	Where & When to Apply	Safety Restrictions	Reference
Citrus Rust Mite	Zineb				Not recommended		Fla. Citrus Spray and Dust Schedule, 1977
Alternatives: Chlorobenzilate		0	LC	1.25 lb (1.25 pt/ 500 gal)		Do not use in alkaline solutions.	
Formetanate hydrochloride (Carzol sp)		7	WSP	0.56-1.15 lb (5-10 oz /500 gals)	Allow 30 days between applications	Do not use on limes or tangelos. Do not use in alkaline solutions.	
Azinphosmethyl (Guthion)		7 (1 application) 26 (2 application)	LC	2.5 lb (5 pt/500 gal)		Do not apply more than 2 times per fruit year.	
Cyhexatin (Plictran)		0	WP	1.25-1.675 lb (20-30 oz/500 gal)		Do not use on tangelos. Do not tank mix with oil. Do not apply to lemons when yellow fruit is present. Avoid applying to new "flush" growth as foliar [illegible]	

Zineb - State Recommendations - Florida Commercial cont.

Site/Pest	Pesticide	Spray harvest interval	Formulation	Rate	Where & When to Apply	Safety Restrictions	Reference *
	Sulfur		WP	50 lb (25 lb/500 gal)	See recommendations for build up of other pests.	Do not use wettable sulfur in combination with oil emulsion. Any application of sulfur should not be be closer than 3 weeks to an oil application.	
	Dialifor (Torak)	7	EC	4.0 lb (4.0 pt/500 gal)	Post bloom or summer spray.	Do not apply more than 2 times/ year. Do not make second application within 3 months if fruits were present on the tree at time of first application.	
	Carbophenothion (Trithion)	0 - 14	EC	2.5-3.75 lb (1.25-1.88 pt 6 lb EC/ 500 gal)	Preferred application in late fall and winter	May injure grapefruit if applied with oil in the summer or if applied alone in the fall before the fruit is fully colored. No preharvest interval if used at not more than 25/lbs actual per acre and 30 days required between applications. 14 day preharvest interval if used at not more than 3.75 lbs actual per acre and 30 days required between applications. 30 day preharvest interval if used at not more than 5 lbs actual per acre.	

Zineb - State Recommendations - Florida Commercial

cont.

Site/Pest	Pesticide	Spray harvest interval	Formulation	Rate	Where & When to Apply	Safety Restrictions	Reference
	Ethion	0	LC	2.5-3.75 lb (2.5-3.75 lb/500 gal)	Preferred use in late fall and winter	No preharvest interval through 7.5 lbs actual per acre; do not repeat application within 90 days on grapefruit, oranges, tangelos and tangerines; do not apply more than 2 times per season on tangerines. 21 day preharvest interval through 7.5 lbs actual per acre on lemons and limes; do not apply more than 1 time per season on tangerines. 30 day preharvest interval from above 7.5 lbs through 16 lbs actual per acre on grapefruit and oranges only.	
	Dioxathion (Delnav)	0	LC	8.0 lb/gal (2 pt/500 gal)	Preferred use during late fall and winter	Do not apply to lemons and limes more than 2 times in one year; do not make second application within 4 months of first. On other citrus do not re-apply within 3 months if fruit is present during first application.	

Site/Pest	Pesticide	Spray harvest interval	Formulation	Rate	Where & When to Apply	Safety Restrictions	Reference
	Dicofol (Kelthane)	21	EC	4 lb/gal (3 pt/500 gal)	Best late fall and winter. Confine use to groves where ethion, trithion, and delnay are no longer useful. Do not use in groves infested with snow scale unless a scalicide is also used.	Do not use in highly alkaline sprays.	
	Propargite (Comite)	7	LC	6.75 lb/gal (25 oz/500 gal)	Preferred use during late fall and winter.	Should no be in highly alkaline solutions (over PH 10), tank mixed with oil, or applied within 2 weeks prior to or following oil treatment. Registered with EPA for oranges, grapefruit and lemons, but has Florida Registration for "citrus." Do not apply more than 2 times per year.	
	Fenbutaxtin-oxide (Vendex)	7	WP	20-40 oz (40 oz/500 gal)		Do not use on limes, tangerines, tangelos. Only 4 applications in any 12 month period. Do not tank mix with oil in sprays to be applied to immature fruit and foliage. Do not apply oil	

Zineb - State Recommendations - Florida Commercial

Site/Pest	Pesticide	Spray harvest interval	Formulation	Rate	Where & When to Apply	Safety Restrictions	Reference
Greasy spot	Zineb	Not recommended					
	Alternatives: Copper			1.25-2.5 16/500 gal	Apply late June to July		Florida Citrus Spray and Dust Schedule, 1977.
	Benomyl (Benlate)	0	WP	1.5-3 lbs/ 500 gals	Apply mid-June to mid-July. Preferred material in groves with high copper content in soil.	Do not use alkaline pesticides as a tank mixture with Benomyl.	
	Oil (83-64%)	0		1.0% 6 gals/500 gals	Preferred material in groves with high copper content in soil.		

Zineb - State Recommendations - Texas

Site/Pest	Pesticide	Spray harvest interval	Formulation	Rate	Where & When to Apply	Safety Restrictions	Reference
Greasy Spot	Zineb				Not recommended		Texas guide for Controlling Pests and Diseases on Citrus, 1978.
	Alternatives						
	Oil	0		10-15 gals/acre	Apply in summer as a scalicide.	Do not use oil if humidity is below 30%.	
	Copper-Count-N	0		4 gals/acre	Post bloom.	Do not apply with oil.	
	Kocide	0		7.5 lbs/acre	Post bloom		
	Oxy-Cop-6L	0		15 lbs/acre	Post bloom		
	Tribasic Copper	0		15 lbs/acre	Post bloom		

[illegible]

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Zineb - State Recommendations - Texas

Site/Pest	Pesticide	Spray harvest interval	Formulation	Rate	Where & When to Apply	Safety Restrictions	Reference
Citrus Rust Mite	Zineb	0	WP (75%)	7.5 lbs. (5 lb/500 gal)	Zineb is unsatisfactory under heavy infestations		Texas guide for controlling pests & diseases on citrus, 1978.
	ALTERNATIVES:						
	Chlorobenzilate	0	4EC	1.5-2.0 pt 1.5-2.0 pt/500 gal			
	Dicofol (Kelthane)	7	4EC	4.0 (2 qt/500 gal)		Do not apply within 90 days of previous application.	
	Ethion	21	rEC	4.0 (2 qt/500 gal)	Do not repeat application within 90 days of previous treatment. Do not apply more than once per season on lemons & limes or twice per season on tangerines.		
	Azinphosmethyl (guthion)	7 (application) 28 (2 applications)	2EC	4.0 (1gal/500 gals)			
	Carbophenothion	14		8 lbs/gal (3.75 pts/500 gal)	Not labeled for use on Kumquat or citron. Do not apply to grapefruit after July 1. Do not apply within 30 days of previous application where more than one application is required.		

_ineb - State Recommendations - Texas (cont.)

Site/Pest	Pesticide	Spray harvest interval	Formulation	Rate	Where & When to Apply	Safety Restrictions	Reference
Citrus rust mites	Sulfur	6	WP	50 25 lbs/ 50 gal		Do not use sulfur with oil or within 30 days of oil spray.	
	Dioxathion (Delnav)	0	4EC	4.0 (2 qt/500 gal)		Do not repeat application within 3 months of previous treatment. Do not repeat within 4 months or apply more than twice a year on lemons or limes may induce armored scale build up. Do not graze or feed cover crop from treated grove.	
	Fenbutaxtin-oxide (Vendex)	7	WP			Apply only with ground equipment, no more than 4 applications per 12 months. Do not apply on tangerines, tangelos. Reed grapefruit or Webb Red Blush grapefruit.	
	Propargite (Comite)	7				Do not use with oil. Labeled only for use on oranges and grapefruit. Do not apply more than twice per year.	

APPENDIX B

USDA Guidelines for Citrus Rust Mite Control

CROP AND INSECT	INSECTICIDE	TOLERANCE	MIN. DAYS FROM LAST APPLICATION TO HARVEST OR FEEDING	FORMULATION	POUNDS OF ACTIVE INGREDIENTS TO APPLY UNLESS OTHERWISE INDICATED		WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
					PER 100 GAL.	PER ACRE		
CITRUS (Con.)								
Mite, citrus rust (Phyllocoptruta oleivora)	Azinphosmethyl	2 fruit 5 dried pulp	28***	EC	0.25	2.5	Post bloom, late spring, fall or winter, in Florida, preferred use is in late fall and winter for combined control of rust mites and spider mites. In Texas, carbophenothion may spot grapefruit if applied after June.	Do not use azinphosmethyl or carbophenothion in home plantings; should be applied only by a trained operator. Allow 30 days between applications of carbophenothion.
	Carbophenothion	2 fruit 10 dehydrated pulp and meal	14	EC or WP	0.25 - 0.37	2.5 - 3.75		
	Dicofol	10	7	EC	0.5	5.0		
	Chlorobenzilate*	5	0	EC or WP	0.12	1.25	Post bloom as needed.	
	Dioxathion	2.8	0	EC	0.25	2.5	Fall, winter	Do not apply azinphosmethyl more than twice per season.
	Ethion	2	21**	EC or WP	0.25	2.5		Limit use of dioxathion as indicated in last column on page 4, 11. Do not feed or graze cover crops grown in treated orchards
	Sulfur	Safe	0	Wettable D	5	40-100	Post bloom as needed.	
Mite, false spider (Brevipalpus spp.) in humid areas	Chlorobenzilate*	5	0	EC or WP	0.25 - 0.5	2.5 - 3.75	Summer.	
	Dicofol	10	7	EC	0.25	2.5	As mites appear.	Do not use dicofol in highly alkaline sprays.
	Sulfur	Safe	6	Wettable	5	50	Summer.	
	Summer Oil	Exempt	0	EC	1.6 gal.	16 gal.	As needed, June 1. September 15.	Limit use of ethion as indicated in last column on page 4, 11. Do not use on citrus citron or kumquats.
Scale, black (Saissetia spp.) in arid areas	Summer oil, light medium or medium	Exempt	0	EC	1.75	55 gal.	As soon as practicable after completion of major hatch of scale. Orange, August-October. Navels through September. Lemons [illegible]	Limit use of oil as indicated in last column on page 4, 11.

* Do not use chlorobenzilate on citrus citron, kumquats, limes, or tangelos. Chlorobenzilate may be applied at 5 lbs. per acre on oranges and 7.5 lb. on lemons.

** No time limit on grapefruit, oranges, tangelos, and tangerines.

*** 7 days if applied only once while fruit is present. Do not do any work involving contact with trees within 7 days after treatment.

Summary of Preliminary Benefit Analysis of EBDC Fungicide Use on Grapes

A. USE: EBDC (Maneb, Zineb) use to control disease on Grapes.

B. MAJOR PESTS CONTROLLED: Black rot, bitter rot, brown rot, ripe rot, bunch rot, deadarm, downy mildew, powdery mildew and anthracnose

C. ALTERNATIVES:

Major registered chemicals:

Benomyl
Captan
Copper Bordeaux
Copper oxide
Copper oxychloride sulfate
Copper sulfate
Copper tetra copper calcium oxychloride
Folpet
Sodium Dimethyldithiocarbamate
Ziram
Gibberallic acid
Botran
Copper ammonium complex
Ferbam

State/federal recommendations: EBDC fungicides are recommended for most of the disease listed above. Most frequently recommended alternatives include ferbam, folpet, captan and benomyl.

Efficacy of alternatives: The best alternatives (captan, benomyl, folpet) for fruit rots are less effective than the EBDC fungicides (maneb and mancozeb), particularly in the Southeast.

Comparative performance: In South Carolina field experiments, black rot losses were significantly reduced with EBDC and alternatives however satisfactory control is difficult when abundant inoculum is present. Downy mildew was controlled best with EBDC compounds while alternatives were ineffective. South Carolina estimates production losses of 15 to 20 percent if EBDC's are not available.

Comparative costs:

Chemical	$/lb Formulated Product	Application Rate Per Acre[1/]	Cost Per Acre Application[2/]
Dithane M-45	1.57	2.0 lbs.	3.14
Manzate	1.57	2.0 lbs.	3.14
Zineb	1.45	2.0 lbs.	2.90
Benomyl	8.30	0.5 lbs.	4.15
Ferbam	1.08	2.0 lbs.	2.16
Captan	1.08	2.0 lbs.	2.16
Folpet	NA	NA	NA

1/ Application Rates from state recommendations

2/ Does not include machinery costs or other variable applications costs.

Conclusion: Available alternatives are less effective for control of black rot, bitter rot and downy mildew.

D. EXTENT OF USE:

State	Bearing Acres	Estimated Percent of Bearing Acres Treated	Estimated Acres Treated Annually
California	576,027	2.1	12,098
New York	42,653	—	—
Michigan	15,761	3.2	500
Pennsylvania	10,388	3.9	400
Ohio	3,900	—	—
Missouri	1,339	40.0	536
South Carolina	1,672	95.0	1,588
Washington	18,549	—	—
North Carolina	2,494	80.2	2,000
Other states	1,936	—	—
Total	674,545	2.5	16,948

E. ECONOMIC IMPACTS: During wet weather or other climatic conditions conducive to downy mildew development, defoliation of vines, damage to ripening fruit and loss of weakened vines can result if an effective EBDC alternate is not available, however, EBDC's are preferred because of superior control of downy mildew. Grape producers in the Southeast may be forced out of production as a result of poor downy mildew control. Impacts could total $2.3 to $3.1 million annually or about 0.5 percent of the value of U.S. grape production.

F. PRINCIPAL ANALYST AND DATE:

Roger C. Holtorf
Economic Analysis Branch
Benefits and Field Studies Division
Office of Pesticide Programs
November 1978

GRAPES

Current Use Analysis

EBDC fungicides are used to control diseases on grapes such as black rot, bitter rot, brown rot, ripe rot, bunch rot, dead arm, downy mildew, powdery mildew, and anthracnose. Alternatives most frequently recommended include folpet, captan and benomyl. However, these fungicides are less effective for downy mildew control.

An estimated 16,950 acres, or about 2.5 percent, of U.S. grapes are treated annually with EBDC fungicides (table ~~#~~ I-58). At the maximum rate of 3 to 4 lbs. a.i. per acre, about 50,850 to 67,800 lbs. a.i. are used for control of grape diseases. While most use (12,100 acres) occurs in California, only 2.1 percent of bearing acres in that state are treated. In contrast, an estimated 80 to 90 percent of bearing acres are treated annually in North Carolina and South Carolina, respectively, totaling about 3,600 acres. Significant acreage is also treated in Missouri, Michigan, and Pennsylvania.

Comparative Performance Evaluation

Most frequently recommended EBDC alternatives include ferbam, folpet, captan and benomyl. These alternatives are less effective than EBDC for fruit rot and downy mildew control. In South Carolina field experiments black rot losses were significantly reduced with EBDC and alternatives, however, satisfactory control is difficult when abundant inoculum is present. Downy mildew was controlled best with EBDC compounds while alternatives were ineffective.

Economic Impact Analysis

If EBDC fungicides are cancelled for use on grapes, production in the Southeast may be reduced by 15-20 percent in the short run. In the long run, producers may be forced out of production following years when climatic conditions are condusive to downy mildew development.

Using a worst case assumption that production on treated acres could be reduced by 15-20 percent, the estimated impact on U.S. grape production could range from $2.3 to $3.1 million annually. This represents about 0.5 percent of the $620 million U.S. grape industry. Most impacts would occur in the Southeast, where downy mildew control is particularly difficult.

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would range from 72.3 to 93.1 million [illegible]

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est impacts would occur in the Southeast, where [illegible]

[illegible]

Limitations of Analysis

(1) Estimates of acres treated with EBDC are not available in all grape producing areas.

(2) Time, manpower, and data constraints severely limit the depth of this analysis.

(3) Data or estimates to determine the mix of alternatives that would be used if EBDC's are cancelled are not available.

(4) Estimated economic impacts reported in this analysis are considered worst case estimates. Current data are not sufficient to more clearly define economic impacts.

I-58

Table 1. Estimated EBDC use on Grapes

State	Bearing Acres	Estimated[5] Percentage of Bearing Acres Treated with EBDC Fungicide	Estimated Base Acres Treated Annually
California[1]	576,027	2.1	12,098
New York[2]	42,653	--	----
Washington	18,549	--	----
Pennsylvania[3]	10,388	3.9	400
Michigan	15,761	3.2	500
Ohio	3,900	--	----
North Carolina	2,494	80.2	2,000
South Carolina	1,672	95.0	1,414
Missouri	1,339	40.0	536
Other States[4]	1,936	--	----
Total	674,545	2.5	16,948

1) California acreages from 1976 state statistics.

2) New York acreages from 1975 state statistics.

3) Pennsylvania acreage from Proceedings of the First Eastern Pine and Meadow Vale Symposium, 1977.

4) Georgia, Connecticut, Delaware, Kentucky, Maryland, Minnesota, New Hampshire, Tennessee, New Jersey, Oregon, and Virginia.

5) California Rebuttal to Presumption Against Registration of EBDC Fungicides, 1978; Clayton, 1978; Spotts, 1978; Steiner, 1978; Maloy, 1978; Peterson, 1978; Yoder, 1978; Covey, 1978; Clemson University, 1978.

SECTION II.

A. TOMATOES FRESH MARKET
B. PROCESS TOMATOES
C. SWEET CORN
D. WATERMELON
E. FRESH MARKET CUCUMBERS
F. CUCUMBERS FOR PICKLES
G. CANTALOUPES
H. SQUASH
I. ONIONS
J. GREEN LIMA BEANS
K. GREEN SNAP BEANS
L. GREEN PEPPERS
M. LETTUCE
N. SPINACH
O. CELERY
P. CABBAGE

ECONOMIC ANALYSIS OF EBDC USE ON VEGETABLES

Introduction

There are 16 vegetable crops (including melons) and peanuts analyzed in this part of the economic assessment. The major impact of an EBDC Cancellation on these crops would be felt in the coastal States, particularly those in the South. Moisture and temperature conditions in these regions tend to generate the most serious fungus problems for the crops included in the group. California and Florida and both major producers of vegetable crops and are the States that would be most directly affected by a cancellation on EBDC use on these commodities.

In the case of most of the commodities, the impact would be felt as an increase in production cost. This increase would be incurred because the preferred alternative fungicide would be more expensive in most cases. With few exceptions, the alternative fungicides would be as effective as the EBDC's in control of the diseases affecting the particular area. Thus, there would be no yield loss on most of the crops in this group if the EBDC fungicides were cancelled.

In some cases the registered alternative material would not be as effective as the EBDC fungicide in controlling the diseases affecting the crop. Yield losses and/or quality reductions would follow the EBDC cancellation. Lettuce and spinach would be two of the crops affected in this way. In the example of lettuce, the best alternative fungicide (copper) would induce both yield and quality reductions. In the case of spinach, there would be no alternative fungicide registered in this areas in which the EBDC fungicides are used.

Assumptions, Procedures and Limitations

1. In assessing the impact of an EBDC cancellation on market price of the commodity, the average annual revenue per acre will be used as a proxy estimate of production cost per acre.
2. It is assumed that the impact of an EBDC ban can be represented by one or a combination of three economic effects. These would include, a change in production cost, change in yield per acre, and a change in the quality of the commodity.
3. The assessment of the initial economic impact will be weighted sum of the percentage change in cost, yield or quality (as reflected in price dockage) which occurs in each affected state or region. Each percentage is weighted by the proportion of total U.S. production accounted for by the particular region or state.
4. The weighted sums used to assess initial economic impact are used in conjunction with the price elasticities of demand and supply to determine the impact on the market price of the commodity. Formulas have been developed which permit the use of the elasticities and the weighted measures of initial economic impact. The derivation of those formulas is explained in the Appendix to this section titled "Practical Techniques for Approximating Commodity Price Impacts of Pesticide Cancellation when Price Elasticities are Available".
5. In situations in which alternatives are used in place of the EBDC fungicide, the explicit assumption is made that the price of the alternative fungicide is not bid upward by the shift.

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6. The cost of application with the alternative fungicide would be equal to that incurred with the EBDC fungicides in all cases.
7. For the purpose of estimating changes in the price of the commodity, an estimate of the cost per unit is required. The assumption will be made that the average price for the U.S. is a valid proxy of the initial cost per unit (see the Appendix).
8. The impact of an EBDC cancellation on each crop is analyzed as though only the individual commodity is affected. No attempt is made to deal with simultaneous impacts and the interrelationships between the commodities on the production and consumption side.
9. The 1975-1977 acres planted and production are used as the quantitative base for the analysis.
10. All of the estimates for acres treated for each crop were provided by the scientists on the EBDC Assessment Team. These estimates were derived from a number of sources. These sources include personal communication with colleagues, published materials on the respective crops and the accumulated knowledge of these crops possessed by Assessment Team members.
11. Information on rates and quantities of application for the EBDC fungicides were provided by the plant pathologists on the Assessment Team. Their sources for this type of information were essentially the same as those mentioned in number 10 above.
12. The information on the use of alternative fungicides was provided by the plant pathologists that assigned to the Assessment Team

In addition to their own knowledge of the respective chemicals and crops, they relied on published material and personal communication with colleagues in providing this information.

13. There are 16 vegetable crops considered in this assessment. Though there are additional vegetable crops on which EBDC fungicides are used, the assessment has been limited to these crops because they represent an extremely high percentage of EBDC use on vegetable crops.

(14) In the event of an EBDC suspension, it is assumed that an alternative fungicide would be used on all of the acreage currently treated with the EBDC fungicides. The two exceptions would be spinach and lettuce. In the case of spinach, no alternative to the EBDC fungicides would be available. In respect to lettuce, the alternative would be partially effective but would be used to a much lesser extent then the EBDC fungicides.

Overview of Economic Impact

Producer Impact

Table II-1 shows the economic impact of an EBDC cancellation on all of the affected crops. In the case of most of the crops, the major impact is manifested in changes in the cost of materials. Column 1 of Table II-1 shows the extra or additional losses that would be incurred by growers for additional material costs. These additonal costs are incurred because growers are forced to go to a more expensive fungicide. The two commodities for which this type of impact would be greatest fresh market tomatoes and lettuce. Together, these commodites account for about 5.3 percent of this type of impact.

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Overview of Economic [illegible]

Producer [illegible]

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Column 2 of Table II-1 shows the extent of the revenue increases (or decreases) that accrue to growers as a result of the cancellation on the use of the EBDC fungicdes. The changes in revenue result from the upward shifts in the price of the commodity. These shifts are in most cases the result of yield reductions induced by the substitution of less effective fungicides. In the case of lettuce, the price increase was significant enough to generate a $59.0 million increase in the total revenue received by all lettuce growers in the United States. The impact for lettuce amounts to 86 percent of the net impact of $68.63 million shown as the total for column 2. The two crops, green peppers, and spinach would also account for major revenue changes as a result of a cancellation on the EBDC fungicides. A $10.0 million increase in total income would accrue to spinach growers if a cancellation were imposed. In the case of green peppers the increase would by $7.4 million.

Column 2 of Table II-1 also shows that the total income received by sweet corn growers would decline if there were a cancellation on the use of EBDC fungicides on both lettuce and sweet corn. The cancellation of EBDC's on lettuce would result in a significant acreage shift in Florida, out of lettuce production into sweet corn. The consequences of this shift would be a reduction on the price of sweet corn faced by all U.S. growers. This reduction in the price of sweet corn would reduce the gross revenue of all sweet corn growers by approximately $10.0 million.

The sum of column 2 in Table II-1 shows the total change in gross income accruing to growers as a result of price changes for all of the affected commodites. Since the elasticities of demand for all

of these commodites are inelastic, the increase in price results in increases in gross incomes for the growers of the commodity. For all crops listed in the table, the total increase in gross income is approximately $68.63 million. This increase in gross income is in part off set by the total in column 1 of the table. The total $30.2 million represents the total additional resource costs that must be faced by the affected growers of all of the commodities listed in Table-II-1. The difference between this total, $30.2 million, and $68.63 million gives the net positive economic impact on growers. It must be born in mind that these totals do not take into account the impacts on net returns of affected growers.

Impact on Consumers

The dollar values in column 3 of Table II-1 represent the estimated impacts on consumers as measured in change in expenditure on the commodity. Certain commodites in the list of seventeen would involve changes in outlays by consumers if the EBDC fungicides were cancelled. With the exception of sweet corn, these commodites would involve additonal total expenditures is at the retail level. The most dramatic increase in total expenditures at the retail level. The most dramatic increase in total expenditures would be for lettuce. The EBDC cancellation would result in an additional outlay of $114.14 million per annum for lettuce (Table II-1). It is apparent that this one commodity accounts for the dominant share of the total estimated negative impact on consumers. The impact of an EBDC cancellation on spinach would also result in a additional

outlay on the part of consumers. In this case the ban would result in added expenditures of $17.8 million (Table II-1).

Watermelons and green snap beans are also commodities for which there would be an additonal outlay by U.S. consumers. However, in both cases, the sums are relatively insignificant. Consumers would spend an extra $1.0 million for watermelon and an additional $2.37 million for green snap beans as result of a cancellation on the EBDC fungicides.

Sweet corn is the only commodity for which there would be a decrease in expenditures on the part of consumers. This decrease amounts to $16.0 million. The decrease occurs primarily because the increase in supply and decrease in price that would occur as lettuce acreage in Florida were shifted from lettuce production into sweet corn production. This shift would occur because a cancellation on EBDC fungicides on lettuce in Florida would leave growers without an effective registered alternative.

Impacts of an EBDC Ban by Commodity

Commodity	Cost of materials 1/	Net producer price impact 2/	Consumer price impact 5/
	millions	millions	millions
Tomatoes fresh market	7.78	—	—
Process tomatoes	2.02	—	—
Sweet corn	1.88	-10.04	- 16.00
Watermellon	3.09	+ 0.69	1.00
Fresh market cucumbers	0.81	—	—
Cucumbers for pickles	0.79	—	—
Cantaloupes	0.25	—	—
Squash	0.57	—	—
Onions	0.52	—	—
Green lima beans	- 0.03	+ 0.13	—
Green snap beans	1.84	1.45	2.37
Green peppers	0.40	+ 7.40	—
Lettuce	0.01	50.80 3/	114.14
Spinach	0.08	10.00 4/	17.80
Celery	.76	—	—
Cabbage	.26	—	—
Total	21.47	60.43	119.31

1/ The numbers in column 1 represent the changes in total outlay for fungicide materials. Positive numbes represent increased in costs and negative numbers represent decreases.

2/ The numbers in column 2 represent changes in gross income accruing to current growers of the respective commodities. The changes would result from changes in the price of the commodity.

3/ The smount of $50.80 million is the net effect of a $59.0 million in crease in gross income resulting from the increase in the price of lettuce and an $8.2 million loss in the gross income of lettuce growers in Florida that would be forced into sweet corn production.

4/ The amount $10.0 million includes an increase in gross income of $6.0 million that would accrue to spinach growers remaining in spinach production. I would also include $4.9 million increase in gross revenue accruing to spinach growers in Texas that would shift into onion production and it would include a reduction of $0.9 million in gross revenue acfruing to spinach growers in Maryland, Virginia, and New Jersey.

5/ The numbers in column 3 represent changes in outlay made by consumers of the commodity. Positive numbers represent increases in expenditures and negative numbers represent decreases in expenditures made by consumers for the commodity.

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING EBDC USE ON TOMATOES

A. USE: EBDC use on commercially produced fresh and processing tomatoes

B. MAJOR PESTS CONTROLLED:

Fresh tomatoes: early blight, late blight, leafmold, and gray leaf spot
Processing tomatoes: early blight, anthracnose, late blight, septoria blight, gray leaf spot, black mold, and botrytis mold.

C. ALTERNATIVES:

Major registered chemicals:

Fresh tomatoes: captan, captafol, chlorothalonil, and anilazine
Processing tomatoes: chlorothalonil, anilazine, captafol (machine-harvest only), and captan.

State recommendations:

	Number of States Recommending for Diseases					
	Late Blight	Early Blight	Anthracnose	Septoria	Botrytis	Gray Mold
EBDC	38	33	23	18	4	16
Chlorothalonil	33	30	21	12	6	14
Captafol	19	15	10	5	0	6
Anilazine	17	10	11	10	3	8
Captan	3	2	3	2	1	2
Benomyl	0	0	0	0	9	0
No alter. recommended	2	2	0	0	0	1

Non-chemical controls: Effective non-chemical control methods are not available.

Efficacy of alternatives: Chlorothalonil and captafol have been found to be slightly more effective than EBDC for disease control on both fresh market and processing tomatoes.

Comparative performance: Use of chlorothalonil on fresh market tomatoes would maintain yields, grade and quality.

Use of chlorothalonil and captafol (used on machine harvested only) on processing tomatoes would maintain yields, grade and quality.

Comparative costs: Fresh market: The preferred alternative would be chlorothalonil. The number of fungicide applications would remain the same. The chemical costs per acre would increase as follows: Florida - $169; California - $23; S. Carolina - $55; Alabama - $40; New Jersey - $34; Michigan - $52; New York - $25; Georgia - $26; Virginia - $30; Maryland - $30; and N. Carolina - $72. These cost increases vary from 0.5% of revenue in California to 4.1% of revenue in Florida.

Process market: In California, 98% of EBDC acreage would be treated with captafol and 20% with chlorothalonil. The weighted cost increase would be $3.56/acre or 0.3% of total revenue. In the remaining states producing process tomatoes, (Ohio, Indiana, New Jersey, Pennsylvania, Michigan, Maryland, and Virginia), 70% of EBDC acreage would be treated with chlorothalonil and 30% would be treated with captafol (captafol may only be used on machine harvested tomatoes). The average cost increase would be $36.00 per acre or 2.7 to 3.6 percent of revenue in these states.

Conclusion: Production, yields, and quality in both the fresh market and the processing market would be maintained with substitute fungicides which are both registered and recommended in several states. Production costs will increase, but not to disruptive levels.

EXTENT OF USE:

Active ingredient basis: 2.6 million pounds per year for both fresh market and processing market tomatoes.

Units treated basis: 151,140 acres divided into 72,052 acres fresh market and 79,088 processing market.

ECONOMIC IMPACTS:

User: Users would be faced with increased production costs as a result of increased chemical costs. The increased chemical cost total $7.8 million with $6.3 million incurred in Florida. Some marginal growers in Florida may be induced to shift to other crops although the impact on production would not be significant in Florida.

Market: Production, prices, and quality of both fresh market and processing tomatoes are not expected to change significantly.

Consumer: No significant impacts.

Macroeconomic: No significant impacts.

SOCIAL/COMMUNITY IMPACTS: Not investigated.

LIMITATIONS OF ANALYSIS:

Usage pattern data used is based on assessment team estimates and not formal user survey.

The propensity of growers in Florida to switch to other vegetable crops depends on the impacts that cancelling EBDC might have on those crops. Data are not available to measure the elasticity of supply on the part of Florida vegetable growers if EBDC were cancelled for several or all vegetables.

PRINCIPAL ANALYST AND DATE:

John Bratland, USDA
Gary Ballard, EPA
November 1978

Fresh Market Tomatoes

Introduction

A number of States would be affected by a cancellation of EBDC fungicides for use on fresh market tomatoes with Florida and California affected to the greatest extent. Florida and California account for 72.4 percent of total U.S. production while the remaining 9 States individually account for relatively small percentages of the U.S. output of fresh market tomatoes (Table II-1).

EBDC Use

California would be affected to a minimum degree since only 11 percent of the acreage is treated with an EDBC fungicide. (1) Also, in California relatively small quantities of these fungicides are used per acre per season when compared to the amounts used in other States (Table II-2).

Florida is more reliant on the EBDC fungicides. About 96 percent of the Florida fresh market tomato acreage is treated with the EBDC fungicides (Table II-1). Also, it is estimated that an average of 21.6 applications of the EBDC fungicides account for 32.4 pounds of active ingredient (a.i.) are being applied per acre per season (Table II-3a).

There are several diseases that affect fresh market tomatoes. These diseases include early blight, late blight, leaf mold and gray leaf spot. (1) The relative extent of infestation of each disease

is uniquely dependent an moisture and temperature conditions.

Alternative Control Program

The major economic loss that would occur as a result of a cancellation of the EBDC fungicides is the additional costs for alternative control materials. There would be no loss in yield because the preferred alternative fungicide, chlorothalonil, is equally effective against the various diseases. Treatment costs per acre for both the EBDC's and chlorothalonil are presented in Table II-3a. The number of applications per season for both EBDC's and chlorothalonil is the same. The total quantity applied per acre does not differ significantly for both the EBDC's and chlorothalonil in each of the States (Table II-3a).

User Impact

Impact on Production Cost

Additional process costs for chlorothalonil for fresh market tomatoes would be \$169.29 in Florida and \$22.80 in California. For the remaining States, the cost increase would range from \$24.70 in New York to \$72.20 in North Carolina (Table II-3a). The costs of chlorothalonil is approximately \$4.75 per pound of active ingredient as compared to \$1.90 per pound of active ingredient for the EBDC's.

Florida's share of total U.S. fresh market production is nearly 40 percent (Table II-1). Florida uses more EBDC fungicides on fresh market tomatoes than any other State producing this crop (Table II-3a). With an average of 21.6 applications per season, the total cost per acre is approximately \$61.56 (Table II-3a). Use of chlorothalonil at the

recommended rate would increase the treatment cost to $230.55 per acre. This increase is due entirely to the difference in cost of the fungicide since the rate and method of application are the same for both the EBDC's and chlorothalonil.

The use of chlorothalonil as a replacement for EBDC fungicides would have less of an impact in the other States that produce fresh market tomatoes. A smaller number of applications per acre per season are required in the other States (Table II-3a). The range of difference in the number of applications per acre for the 10 States would be 4 for California and Georgia to 10 for South Carolina (Table II-3a). It is apparent that there is much less reliance on EBDC fungicides in these other producing States.

Changes in Yield, Quality and Production

As indicated above, the use of the alternative fungicide, chlorothalonil, would not result in any yield reductions. Also, since chlorothalonil is equally effective for virtually all diseases that infest tomato crops, the grade and quality of the commodity would be maintained.

Changes in Commodity Prices and Farm Income

Although changes in quality or yield per acre are not expected, there would be an increase in production costs as a result of using an alternative fungicide in place of the EBDC's. EBDC fungicides are currently used on 55 percent of U.S. production. As production costs increase, growers may go out of production and/or those remaining in production may shift their marginal acreage to alternative crops

or use less inputs on acres remaining in production. These adjustments on the part of growers would reduce the available supply of fresh market tomatoes.

To estimate the impact of increased production costs on fresh market tomato prices, it is necessary to determine the percentage increase in production costs that would result from a cancellation of the EBDC fungicides. However, difficulties arise in trying to obtain appropriate cost information. Production costs vary widely throughout the U.S.; also production budgets are not available at the State or regional level. Production budgets have been developed for local areas but it would not be prudent to use them for a national level analysis.

There is an alternative approach that can provide estimates of production cost. In theory, when a competitive industry is in long-run equilibrium, average revenue per acre equals average cost per acre and commodity price is equal to production cost per unit of output. Specifically, a state of equilibrium in an industry implies that the average revenue (per acre and per unit) is adequate to cover average cost per acre inclusive of the normal competitive returns to entrepreneurial talent, managerial effort, risk return on capital and returns to land. If this condition exists within an industry there is no incentive on the part of growers to expand or contract production or for potential "new" growers to enter the industry. 1/ The foregoing conditions are rather strict and never exist in reality. However, this theoritical approach does provide an indication of how changes in production costs as a resulting from the cancellation of the EBDC fungicides may affect national level fresh market tomato prices.

1/ See the Appendix for a more detailed review of these concepts.

The average revenue per acre over the period 1975-77 is used in this analysis to approximate long-run average cost of production per acre. Thus estimated long-run average production costs range from about \$4,600 per acre in California to about \$1,200 in Maryland (Table II-3b).

In order to estimate the change in the average U.S. market price that would result from an EBDC cancellation, it is necessary to develop a weighted averagechange in production cost for the entire U.S. The estimated percentage change in average production costs ranges from 4.1 percent in Florida to 0.5 percent in California (Table II-3a). Each of these percentage changes is weighted by the proportion of total U.S. production treated in the respective States. The weighted average increase in U.S. production costs for fresh market tomatoes is estimated at 1.95 percent as a result of a cancellation of the EBDC fungicides.

The percentage increase in the price of fresh market tomatoes would be estimated on the basis of estimated percentage change in production cost and estimated values for the elasticities of demand and supply. The elasticity of demand for fresh market tomatoes has been estimated to be 0.198 (3) and the elasticity of supply to be 0.237 (4). The percentage change in price is estimated to be equal to 0.89 percent. 2/ Since the percentage change is less than one percent, there would be singnigicant impact on national level fresh market tomato prices.

2/ The technique used in making this estimate relies on the following formula:

$$\% \text{ change in price} = \frac{\text{weighted percent change in Production Cost}}{1 + \dfrac{\text{price elasticity of demand}}{\text{price elasticity of supply}}}$$

% change in price = 0.89 %
weight % change in production cost = 1.95%
price elasticity of demand = 0.237 (absolute value)
price elasticity of supply = 0.195
See the Appendix for a detailed explanation of the use of the formula.

With the price of fresh market tomatoes remaining roughly constant, the economic loss that would be incurred by growers is the increase in fungicide material cost. The dollar impact would range from $6.3 million in Florida to $25,000 in New York (Table II-3a).
The total losses incurred by growers because of increased material cost would be approximatley 7.8 million if the EBDC fungicides were cancelled for this use.

Impact on Net Returns

A cancellation of EBDC use for fresh market tomatoes would result in some change in the net return per acre in each of the affected States. Impacts in Florida warrant attention for several reasons. First, 81.1 percent of the "losses" occur within this State. Second, the dollar increase in material cost per acre is higher in Florida than in any of the other 10 affected States. Third, the proportion of the total U.S. production treated with EBDC's in Florida is higher than in any of the other affected States. Since 96 percent of the Florida acreage is treated with the EBDC fungicide, nearly all growers in the State would be affected by higher cost of chlorothalonil treatments.

The returns to land, labor and management for the 3 production areas are examined. These are Mantee-Ruskin, Immokalee-Lee and Dade County. The returns are based on a 5 season average of production budgets over the period 1972-76 (Tables II-4, II-5, and II-6). The net return per acre in each area and the return that would occur after an EBDC cancellation

are as follows:

Area	Returns before cancellation	Returns after cancellation	Percent change
Mantee-Ruskin	590.96	421.67	29 %
Immokalee-Lee	537.93	368.64	31 %
Dade County	279.75	110.46	61 %

It is possible that such reductions in net return per acre of fresh market tomatoes could induce shifts to other commodities. Any of the more profitable crops may attract acreage of the Florida fresh market tomato growers if differentials in net return per acre were expected to persist for an extended period. However, data on net returns for individual vegetable crops in Florida shows a great deal of variability both geographically and intertemporally (over time).

Another difficulty encountered in estimating acreage shifts for fresh market tomatoes is that several alternative crops may be affected by an EBDC cancellation. If several crops are simultaneously affected by a cancellation, the adjustments in price, outputs, revenues and costs for individual crops would be more difficult to estimate.

Consumer Impact

Grade or quality of fresh market tomatoes would not be reduced by the use of alternative fungicides to replace the EBDC's.

These production costs would increase and in the long-run with minimal change in retail price. However, no important change in consumer expenditures is expected in near term.

Table II-2 Acreage and production affected - fresh market tomatoes

States	Average acres planted 1975-77 1/	Percent acres treated EBDC 1976 2/	Expected annual acres treated with EBDC	Average production 1975-77 3/ (1,000 cwt)	Percent of total U.S. production	Percent of total U.S. production treated in the State
Florida	38,933	96	37,376	8,201	39.5	37.9
California	29,800	11	3,278	6,834	32.9	3.6
South Carolina	8,533	100	8,533	746	3.6	3.6
Alabama	8,300	88	7,304	551	2.7	2.4
New Jersey	6,766	43	2,909	559	2.7	1.2
Michigan	4,433	100	4,433	395	1.9	1.9
New York	3,267	31	1,013	312	1.5	0.5
Georgia	3,066	100	3,066	188	0.9	0.9
Virginia	2,567	40	1,027	312	1.5	0.6
Maryland	2,333	42	980	209	1.0	0.4
North Carolina	2,133	100	2,133	285	1.4	1.4

1/ Vegetables 1977 Annual Summary, Crop Reporting Board, USDA.

2/ Assessment of EBDC Fungicide Uses in Agriculture Part II, USDA/STATE/EPA Assessment Team, April, 1978.

3/ Vegetables 1977 Annual Summary.

Table II-3a Treatment cost per acre and total- Fresh Market Tomatoes

State	Average number of EBDC appl. per acre 1/	Lbs. active ing. appld. per acre per appl. 2/	Est. EBDC a.i. applied per acre per season	Est. materials cost per acre with EBDC fungicides 3/	Est. quantity of preferred alternative used per acre per season (units a.i.) 4/	Est. materials cost per acre with the preferred alternative 5/	Dif. in material cost per acre wth alt.	"Total added costs for State" 6/
Florida	21.6	1.5	32.4	61.56	48.6	230.85	169.29	6327.4
California	4.0	2.0	8.0	15.20	8.0	38.00	22.80	74.7
South Carolina	8.0	1.4	11.2	21.28	16.0	76.00	54.72	466.9
Alabama	7.0	2.0	14.0	26.60	14.0	66.50	39.90	291.4
New Jersey	6.0	2.0	12.0	22.80	12.0	57.00	34.20	99.5
Michigan	8.0	1.6	12.8	24.32	16.0	76.00	51.68	229.1
New York	5.0	2.4	12.0	22.80	10.0	47.50	24.70	25.0
Georgia	4.0	1.6	6.4	12.16	8.0	38.00	25.84	79.2
Virginia	6.0	2.4	14.4	27.36	12.0	57.00	29.64	30.4
Maryland	6.0	2.4	14.4	27.36	12.0	57.00	29.64	29.0
North Carolina	10.0	1.2	12.0	22.80	20.00	95.00	72.20	154.0

1/ Assessment of EBDC Fungicide Uses In Agriculture, Part II USDA/STATE/EPA Assessment Team April, 1978." "the specific EBDC fungicides are maneb, zineb and mancozeb

2/ Ibid.

3/ The price of EBDC is an average derived from several price lists. The estimated price of the EBDC fungicides is about $1.90 per Lb. a.i.

4/ Bravo or chlorothalonal is the alternative that would be used. Source: Assessment of EBDC---Part II.

5/ The estimated price of chlorothalonil is $4.75 per lb. a.i. The estimate is an average derived from several price lists.

6/ These estimates are arithmetic products of the treated (Table II-2) and the added cost per acre treated.

...oduction Cost- Fresh Market tomatoes

State	Proportion U.S. production treated in the state 1/	Average revenue per acre (1975-1977) (est. ave. cost) 2/	Increase in material cost with alt. 3/	Est. percent change in cost per acre	Est weighted percentage impact on U. ave. product cost 4/
Florida	0.379	4169	169.29	4.1	1.55
California	0.036	4606	22.80	0.5	0.02
South Carolina	0.036	1569	54.72	3.5	0.12
Alabama	0.024	1563	39.90	2.6	0.06
New Jersey	0.012	1549	34.20	2.2	0.03
Michigan	0.019	1579	51.68	3.3	0.06
New York	0.005	1849	24.70	1.3	0.01
Georgia	0.009	1262	25.64	2.0	0.02
Virginia	0.006	1859	29.64	1.6	0.01
Maryland	0.004	1168	29.64	2.5	0.01
North Carolina	0.014	.2015	72.20	3.6	0.05
Total	0.544				1.95

1/ Source: Vegetable 1977 Annual Summary, Crop Reporting Board, USDA. The proportions are obtained by dividing the percentages in the rightmost column of Table II-2 by 100. The total 0.544 represents the proportion of U.S. production treated.

/ Source: Ibid. The average revenue per acre is assumed to be equal to average cost per acre for the purpose of this assessment. The rationale for this assumption is outlined in the Appendix.

Source: See Table II-3a.

Each item in the column represents the percentage impact on average U.S. production cost originating in each State. The total 1.95 represents the weighted percent change in average U.S. production cost of fresh market tomatoes that would result from an EBDC cancellation.

Table II-4. Tomatoes: Costs and returns in the Manatee-Ruskin area 5-season average 1972-76*

Item	5-season average
Number of growers	12
Number of acres	2232
Average acres per grower	186
Average yield per acre (30 lb.)	715
Growing costs:	Average per Acre
Land rent	$ 42.65
Seed	59.54
Fertilizer	213.54
Spray and dust	204.20
Cultural labor	419.64
Machine hire	21.83
Gas, oil and grease	68.03
Repair and maintenance	80.96
Depreciation	67.14
Licenses and insurance	61.66
Interest on production capital (9% - 5 months).	48.69
Interest on capital invested (other than land).	10.07
Miscellaneous expense	126.36
Total growing cost	1424.31
Harvesting and marketing costs:	
Picking expense	330.41
Grading and packing expense	701.28
Containers	329.14
Hauling	90.17
Selling	91.73
Total harvesting and marketing cost	1542.73
Total crop cost	2967.04
Crop sales	3558.00
Net return	$590.96

	1976-77 range per acre From	To
Yield (30 lb.)	483	1223
Total growing cost	$1249.12	$ 2576.19
Total harvesting and marketing cost	1141.33	2719.23
Total crop cost	2495.36	4650.34
Crop sales	1975.91	5457.78
Net return	$-781.61	$ 952.13

*Source: D.L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 With Comparisons, Institute of Food and Agricultural Science, University of Florida, March 1978.

Table II-5. Tomatoes: Costs and returns in the Immokalee-Lee area
5-season average 1972-76*

Item	5-season average
Number of growers	13
Number of acres	3133
Average acres per grower	241
Average yield per acre (30 lb.)	910
Growing costs:	Average per Acre
Land rent	$ 35.76
Seed	79.42
Fertilizer	240.99
Spray and dust	328.50
Cultural labor	644.63
Machine hire	85.25
Gas, oil and grease	76.40
Repair and maintenance	116.29
Depreciation	84.82
Licenses and insurance	56.29
Interest on production capital (9% - 5 months)	69.88
Interest on capital invested (other than land)	12.72
Miscellaneous expense	200.02
Total growing cost	2030.97
Harvesting and marketing costs:	
Picking expense	605.30
Grading and packing expense	789.52
Containers	396.49
Hauling	118.44
Selling	125.28
Total harvesting and marketing cost	2035.03
Total crop cost	4066.00
Crop sales	4603.93
Net return	$537.93

	1976-77 range per acre: From	To
Yield (30 lb.)	286	900
Total growing cost	$ 909.48	$ 3142.48
Total harvesting and marketing cost	729.30	2164.63
Total crop cost	1813.07	4786.34
Crop sales	1627.04	6029.84
Net return	$ -393.63	$ 1243.50

* Source: D.L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 With Comparisons, Institute of Food and Agricultural Science, University of Florida, March 1978.

Table II-6. Tomatoes: Costs and returns in the Dade County area 5-season average 1972-76*

Item	5-season average
Number of growers	7
Number of acres	5810
Average acres per grower	830
Average yield per acre (30 lb.)	507
Growing costs:	**Average per Acre**
Land rent	$ 36.04
Seed	22.06
Fertilizer	215.23
Spray and dust	230.73
Cultural labor	184.32
Machine hire	21.79
Gas, oil and grease	30.85
Repair and maintenance	56.25
Depreciation	43.48
Licenses and insurance	27.77
Interest on production capital (9% - 5 months)	33.52
Interest on capital invested (other than land)	6.52
Miscellaneous expense	68.95
Total growing cost	977.51
Harvesting and marketing costs:	
Picking expense	292.15
Grading and packing expense	415.51
Containers	240.50
Hauling	54.35
Selling	70.85
Total harvesting and marketing cost	1073.36
Total crop cost	2050.87
Crop sales	2330.62
Net return	$279.75

	1976-77 range per acre	
	From	To
Yield (30 lb.)	61	393
Total growing cost	$ 869.70	$ 1415.19
Total harvesting and marketing cost	146.22	954.99
Total crop cost	1015.92	2134.39
Crop sales	436.15	2333.29
Net return	$ -394.97	$ 178.90

*Source: D.L. Brooke, Costs and Returns from Vegetable Crops in Florida Season 1976-77 With Comparisons, Institute of Food and Agricultur Science, University of Florida, March 1978.

Process Tomatoes

Introduction

The major impact of an EBDC cancellation on process tomatoes would occur in the 7 eastern producing States (Table II-7). California accounts for 83.6 percent of U.S. production of process tomatoes but only 9 percent of the acreage is currently treated with the EBDC fungicides (Table II-7). The impacts at the production level in California are further minimization since only 4 applications are applied during the season. The percent of acres treated in the 7 affected eastern producing States ranges from 50 percent in Maryland to 99 percent in Ohio. It is estimated that 16 applications are applied per season in these States.

There are several diseases that affect process tomatoes. The diseases include early blight (anthracnose), late blight, (septaria), gray leaf spot, black mold and botrytis mold. 5/ Apparently all of the diseases occur in each of the affected growing areas; however, late blight would be a more common problem in cool climates such as the midwest and Pennsylvania.

Alternative Control Programs

Chlorothalonil and captafol are two fungicides that are recommended and would serve as major replacements for EBDC fungicides in the event of a cancellation. 1/ Both alternative fungicdes would be equally effective against the major diseases that affect this crop. Captafol is registered on the process tomatoes which are to be machine harvested. Chlorthalonil would be the major replacement for the EBDC fungicide in 7 of the 8 affected States since, in all of the States but California, hand picking is the predominant harvesting mode. It is assumed that

[illegible] would

[illegible] producing States (Table [illegible]). California accounts

of U.S. production of [illegible]

currently [illegible] with the [illegible]

of the production level in California [illegible]

[illegible] are applied [illegible]

In the affected areas producing [illegible]

land to 99 percent [illegible] is estimated [illegible]

applied per season in [illegible] State.

several diseases that affect [illegible]

[illegible] blight ([illegible]), late blight, ([illegible]) gray leaf spot,

bacterial [illegible]. Apparently all of the diseases occur

affected growing areas, [illegible] late blight would be

[illegible] in cool climates such as the midwest and Pennsylvania.

[illegible] and captafol are the fungicides [illegible] recommended

major replacements for [illegible] fungicides in the event

[illegible] alternative fungicides would be equally

The major diseases that affect this crop. [illegible]

[illegible] to be reaching [illegible]

[illegible]

[illegible]

[illegible]

captafol would be the major replacement in California if the EBDC fungicides were cancelled. Chlorothalonil would be the alternative used on 70 percent of acreage in the states of Ohio, Indiana, New Jersey, Pennsylvania, Michigan, Maryland, and Virginia (Table II-8a). Captafol would be used on the remaining 30 percent of the acreage in these States. The percentages reflect estimates of the proportion of acreage still hand harvested in areas outside of California. Of the estimated 25,563 acres in California that are currently treated with EBDC fungicides, 98 percent would be treated with captafol if the former fungicides were no longer available (Table II-8a).

User Impact

Impact on Production Cost

As indicated above, chlorothalonil and captafol would be the major replacements if EBDC's were cancelled from use on process tomatoes. Captafol costs approximately $2.75 per lb. (a.i.) while chlorothalonil costs about $4.75 per pound. The approximate average prices of the alternatives are higher than that of the EBDC fungicides which have an estimated average price of approximately $1.90 per lb. (a.i.) (Table II-8a).

The prevalence of machine harvesting in California means that captafol would be the preferred replacement in this State. About 98 percent of the acreage currently treated with EBDC's would be treated with captafol and 2 percent would be treated with chlorothalonil. The weighted average increase in material cost per acre in California would be $3.76 (Table II-8a).

The greater incidence of hand harvesting outside of California means that chlorothalonil would be used more frequently than captafol. The cost increase per acre associated with an EBDC cancellation would be greated in the other seven States than in California. A cancellation would shift material costs upward from $30.40 to $66.40 per acre (Table II-8a). The additional weighted cost per acre in these seven states is approximately $36.00.

Changes in Yield, Quality and Production

There would be no change in yield or production levels by using chlorothalonil or captafol as alternates for the EBDC fungicides. Also, quality would be maintained with the alternative materials.

(4) Changes in Commodity Price and Farm Income

A cancellation of the EBDC fungicides on process tomatoes would induce no change in quality or yield per acre. However, there would be an increase in production cost because more expensive fungicides would be used instead of the EBDC's. The EBDC fungicides are currently used on about 20 percent of U.S. process tomato production (Table II-7). The same theory, rationale and assumptions as were used in the analysis of U.S. fresh market tomato prices will be employed here to estimate percentage change in average production cost. (See page II-12 and the Appendix to the vegetable section)

The average revenue per acre over the period 1975-77 is used in the analysis to approximate long run average cost of production per acre. The estimated long-run average production cost range from about $1370 in California to about $640 in Virginia (Table II-8b). These estimates

of average cost will be used as a base in estimating the change in production cost that would result from the cancellation of the EBDC's.

An estimate of the average change in U.S. market price requires the use of a weighted average estimate of change in production cost for the entire U.S. For process tomatoes, the estimated change in average production cost ranges from 5.6 percent in Virginia to 0.3 percent in California, the most important producting State (Table II—8b). Each of the percentage changes in production cost must be weighted by the proportion of total U.S. production treated in the respective States (proportions are shown in Table II-8b). The estimated weighted average increase in U.S. production costs for fresh market tomatoes is about 0.42 percent (Table II-8b). This percentage represents the estimated percentage increase in U.S. production cost of process tomatoes that would occur because of a cancellation of EBDC's.

The percentage increase in the price of process tomatoes would be a function of the estimated percentage change in production cost and the estimated values for the elasticities of supply and demand. The estimated elaticity of demand for process tomatoes is 0.176 (11). The elasticity of supply that will be used is 0.198 (4). 3/ The estimated percentage

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3/ The supply elasticity is that was used in the section on fresh market tomatoes. Many of the same States are involved with the production of both commodities. This fact would lend legitimary to the assumption that the two elasticities may be similar.

change in price is 0.22 percent. 4/ Since the calculated percentage in price is less than one percent, there would be an insignificant impact on the U.S. average market for process tomatoes.

The impact of a cancellation of EBDC fungicide use would be reflected mainly in the increased production cost imposed on growers. The loss incurred by growers in the affected area would be the additional outlays necessary for more expensive fungicides. The total dollar losses would range from $810.2 thousand in Ohio to $79.8 thousand in Maryland (Table II-8a). In all of the affected States combined the total losses would amount to approximately $2.0 million.

As noted above, the State that would incur the largest impact is Ohio with 40.2 percent of the total U.S. increase in production cost outlays. The impact of the cost increases on the net returns per acre in Ohio will be analyized in the next section.

4/ The technique used in making this estimate is based on the use of the following formula:

$$\%\text{ change in price} = \frac{\text{weighted percent change in production cost}}{\left(1 + \frac{\text{price elasticity of demand}}{\text{price elasticity of supply}}\right.}$$

% change in price = 0.22 %
Weighted percent change in production = 0.42 %
Price elasticity of demand = 0.176
Price elasticity of supply = 0.198

See the Appendix for a detailed explanation of how the formula is derived and how the formula is used.

The Impact on Net Returns

Since the greatest dollar impact of an EBDC cancellation on process tomatoes would occur in the State of Ohio, some attention will be given to the cost increase of $36.00 and its impact on net returns. Table 2-8 shows a production cost budget for hand harvested processing tomatoes in Ohio. In the budget, there are three different sets of cost and receipt data for three different yield levels. The three different values for total receipts per acre are $1,1134.00, $1,512.00 and $1,890.00 which correspond to the respective yields of 18, 24 and 30 tons per acre (1978). The total costs incurred with respective yield levels are $1,127.00, $1,221.00 and $1,410.00. Thus,the estimated net return per acre before and afer an EBDC cancellation would be as follows:

	Net Revenue	
Yield	Before cancellation	After cancellation
18 ton	$ 7.00	$ -29.00
24 ton	291.00	255.00
30 ton	480.00	444.00

On the acreage yielding 18 tons per acre, it is apparent that the cancellation of EBDC's would produce a loss per acre $29.00. However, at the other yield levels there would still be sizeable returns per acre.

From Table II-7 the average yield per acre can be calculated for the process tomato acreage in Ohio. The average yield for the period 1975-77 was approximately 20 tons per acre. With the Ohio price of $63.00 (shown in Table II-9) such a yield level would generate revenue of $1260.00 per acre. The estimated cost per acre on acreage yielding 20 tons can be approximated by noting that there are only three cost items in the budgets that vary with the yield level (Table II-9). These are hand labor for harvesting, the labor charge in overhead, and management. The first step in estimating the costs of these items at a yield of 20 tons is to determine the difference in the cost incurred at 24 tons and at 18 tons. These cost levels should be added to the costs associated with the 18 ton per acre yield level. This sum should give a good approximation of the costs that would be incurred for these three items at a yield level of 20 tons. The estimated production cost would be $1157.00. The net return per acre would be $103.00 for the average of 20 tons per acre. A cost increase of $36.00 per acre would reduce this net return to $67.00 per acre. It is possible that such a reduction in net revenue per acre would induce a shift to other crops on the affected acreage. Other alternative crops to which the acreage could shift include navy pea beans, sugar beets, potatoes and sweet corn. 5/ With the exception of the latter crop,

5/ These alternative crops are those for which other budgets are available. See the source for Table II-9.

these alternative crops would not permit a net return per acre sufficiently great to warrant the shift. On sweet corn, the net revenue per acre ranges from $84.00 to $184.00. (22) A more likely possibility than switching to an alternative crop would be a switch to machine harvesting of process tomatoes. With machine harvesting, the cost per acre on acreage yielding 20 tons would be approximately $1,027.00. 6/ Machine harvested process tomatoes would generate a revenue per acre of approximately $1,230.00. 7/ Net revenue in this case would be $203.00 prior to the cancellation of EBDC fungicides and would be $167.00 following any such action. Thus, it would appear that production levels of process tomatoes in Ohio would be maintained if the EBDC fungicides were cancelled. However, a cancellation could induce a shift away from hand harvesting to machine harvesting as growers attempt to minimize costs. 8/

Acreage Shifts to Other Commodities

Clearly there would be some effect on net return per acre in each of the 8 States affected by an EBDC cancellation on process

6/ The method used in making this estimate is the same as that used for hand harvested tomatoes (22).

7/ This estiamte is based upon an average price in Ohio of $61.50 per ton (22).

8/ Presumably, this shift is already occuring because of the differences in net return (22).

tomatoes. However, it cannot be said conclusively that a cancellation would induce any shift in acreage to other commodities.

Consumer Impact

(1) Changes in quantity and quality of the product available

A cancellation of the use of EBDC fungicides on process tomatoes would not change yield in any of the affected States. There would thus be no reduction in the quantity of the commodity available.

The cancellation of use of EBDC's on process tomatoes would not change the quality of the commodity marketed. The use of the preferred alternative fungicides would prevent any reduction in quality.

Changes in Consumer Expenditures

Since the price of process tomatoes would not be affected to any important degree, there would be no measurable impact on consumers.

Table II-7 Acreage and Production Affected - Process Tomatoes

States	Ave. acres planted 1975-1977 1/	Percent acres treated - EBDC 1976*	Expected annual acres treated with EBDC	Ave Production 1975 - 1977 (Tons) 3/	Percent of total U.S. production 1975 - 1977 4/	Percent of total U.S. Production treated in the state 5/
California	284,003	9	25,563	6,335,517	83.6	7.5
Ohio	22,733	99	22,506	453,333	6.0	5.9
Indiana	14,367	84	12,068	205,483	2.7	2.3
New Jersey	9,500	64	6,080	150,483	2.0	1.3
Pennsylvania	6,567	69	4,531	116,283	1.5	1.0
Michigan	4,333	73	3,163	67,100	0.9	0.7
Maryland	4,433	50	2,217	49,417	0.7	0.4
Virginia	3,700	80	2,960	35,750	0.5	0.4

1/ Vegetables 1977 Annual Summary Crop Reporting Board, USDA.

2/ Assessment of EBDC Fungicide Uses In Agriculture, Part II, USDA/STATE/EPA Assessment Team, April, 1978.

3/ Vegetables 1977 Annual Summary.

4/ Ibid.

5/ These percentages are derived from the information given in columns 2 and 5 of these tables.

Table II-8a. Treatment cost per acre and total – process tomatoes

STATE	Ave. number of EBDC applications per acre 1/	Estimated EBDC A.I. applied per acre per season	Estimated materials cost per acre with EBDC fungicides 2/	Estimated quantity of preferred alternative used per acre season (Units A.I.) 3/	Proportion of acreage on which the respective alternatives would be used: Chlorothalonil	Proportion of acreage on which the respective alternatives would be used: Captafol	Weighted ave. materials cost per acre with the preferred alternatives 5/	Difference in material cost per acre with alternatives	Total cost impact for the State (1,000 dol.) 6/
California	2	4	7.60	4	0.02	0.98	11.16	3.56	91.0
Ohio	8	16	30.40	16	0.70	0.30	66.40	36.00	810.2
Indiana	8	16	30.40	16	0.70	0.30	66.40	36.00	434.4
New Jersey	8	16	30.40	16	0.70	0.30	66.40	36.00	218.9
Pennsylvania	8	16	30.40	16	0.70	0.30	66.40	36.00	163.1
Michigan	8	16	30.40	16	0.70	0.30	66.40	36.00	113.9
Maryland	8	16	30.40	16	0.70	0.30	66.40	36.00	79.8
Virginia	8	16	30.40	16	0.70	0.30	66.40	36.00	106.6
Total									2,017.9

1/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978. The specific EBDC fungicides used are maneb and mancozeb.

2/ The estimated average price of the EBDC fungicides is $1.90 per lb. a.i. The price for EBDC is an average derived from several current lists.

3/ Both Captafol and Chlorothalonil would be used in the various affected states. Both alternatives would be applied at the same rate and same total amount as the EBDC fungicide, that is 4 lbs. per acre per season in California and 16 lbs. active ingredient per acre per season in each of the other affected states. Source: Assessment of EBDC Fungicide Uses in Agriculture, Part II.

4/ These estimates were provided through personal communication with Dr. James Kuntzes, Plant Pathologist, University of Maryland and member of the EBDC Assessment Team.

5/ These estimates were derived by multiplying the proportions of the acreage treated with each material times the price of the respective material times the quantity of the material applied during the season. The estimated price of Chlorothalonil is $4.75 per lb. a.i. and the price for Captafol is $2.75 per lb. a.i. Both prices represent averages derived from several current price lists.

6/ These estimates are arithmetic products of the acres treated (Table II-7) and the difference in material cost per acre with the alternative.

Table II-8b. Impacts on Production Cost- Process Tomatoes

State	Proportion of U.S. production treated in the States 1/	Ave. Revenue per acre 1975-77 (est. ave. cost) 2/	Increase in material cost with alt. fungicide 3/	Est. percent change in cost per acre	Est weight percent in on U.S. av production
California	0.075	1368	3.56	0.3	0.02
Ohio	0.059	1329	36.00	2.7	0.15
Indiana	0.023	929	36.00	3.9	0.09
New Jersey	0.013	1061	36.00	3.4	0.04
Pennsylvania	0.010	1121	36.00	3.2	0.032
Michigan	0.007	1007	36.00	3.6	0.025
Maryland	0.004	737	36.00	4.9	0.020
Virginia	0.004	640	36.00	5.6	0.022
Total	0.195				0.415

1/ Source: Vegetable 1977 Annual Summary Crop Reporting Board, USDA. The proportions are obtained by dividing the percentages in the right most column of Table II-7 by 100. The total 0.195 represents the proportion of U.S. production treated.

/ Source: Ibid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the appendix.

/ Source: See Table II-8a.

/ Each item in the column represents the percentage impact on U.S. production cost originating in the state. The column total, 0.415, represents the weighted percent change in average U.S. production cost of process tomatoes that would result from an EBDC cancellation.

Table II-9. 1978 Processing tomato production budget and harvest

ITEM	EXPLANATION	PRICE PER UNIT	YIELD/ACRE		
			18 T.	24 T.	30 T.
RECEIPTS		$63.00/T.	$1134	$1512	$1890
CASH COSTS					
Plants	9000	$ 9.50/1000	$ 36	$ 36	$ 36
Fertilizer 1/		93	93	93	93
Chemicals					
Herbicide		30	30	30	30
Fungicide		63	63	63	63
Insecticide		17	17	17	17
Ripener		5	5	5	5
Hired Labor					
Setting	13 hr.	$ 3.00/hr.	39	39	39
Hoeing	7 hr.	$ 3.00/hr.	21	21	21
Harvesting	65 hampers/T.	$ .28/hamper	328	390	546
Hail Insurance			10	10	10
Hampers	75/A.	$ .23/hamper 2/	17	17	17
Inspection		$ .25/T.	5	6	8
Fuel, Oil, and Grease			32	34	36
Repairs			20	22	24
Tractor Rental 3/			10	10	10
Miscellaneous 4/			5	5	5
Interest on Oper. Cap. 5/	6 mo.	8.5%	18	18	18
Total Cash Costs			$ 799	$ 866	$1028
OVERHEAD COSTS:					
Housing Charge 6/			$ 41	$ 41	$ 41
Labor Charge	10, 12, 14 hrs.	$ 4.00/hr.	40	48	56
Mach. and Equip. Charge			90	90	90
Land Charge			100	100	100
Management Charge	5% of Gross Income		57	76	95
Total Overhead Costs			$ 328	$ 355	$ 382
TOTAL COSTS			$1127	$1221	$1410
RETURN ABOVE CASH COSTS			$ 335	$ 646	$ 862
RETURN ABOVE TOTAL COSTS			$ 7	$ 291	$ 430

1/ Assumes maintenance fertilizer only.
2/ Hamper cost = $.54/hamper ÷ 2 year life = $.27 average costs, times 10% interest = $.027. Total $.297 X 75% usage on tomatoes = $.23.
3/ Additional tractor rented for planting.
4/ Includes supplies, utilities, soil tests, small tools, etc.
5/ Does not include interest on harvesting costs.
6/ Housing cost: $12,000 investment X 19.5% overhead X 75% use on tomatoes = $1755. Trash pickup, utilities, land charge, water = $691. Total cost: $2446 ÷ 30 workers X .5 worker per acre = $41 housing cost/A.

SOURCE: Ohio Crop Enterprise Budgets 1978 Speciality Crops. Prepared by Area and State Extension Farm Management Faculty, Department of Agricultural Economics and Rural Sociology in consultation with Area and State Extension Faculty in the Department of Agronomy, Department of Horticulture, Ohio State University

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING EBDC USE ON SWEET CORN

A. USE: EBDC use on commercial sweet corn production.

B. MAJOR DISEASES CONTROLLED: Northern Leaf Blight, Southern Leaf Blight, and Rust

C. ALTERNATIVES:

Major registered chemicals: Chlorothalonil and captafol (pre-RPAR)

State recommendations:

	Number of States Recommending Diseases: Leaf Blights	Rust
EBDC		
Chlorothalonil	22	6
Captafol**	12	
No Alternative	1	
EBDC Recommended	8	6

** Pre-RPAR chemical

Non-chemical controls: Not available.

Efficacy of alternatives: Chlorothalonil and captafol would permit the same level of disease control as EBDC.

Comparative performance: Yields and quality would be maintained if chlorothalonil and captafol were substituted for EBDC.

Comparative costs:

	EBDC	Season Chemical Cost Per Acre: Chlorothalonil	Captafol	Differences
Florida1/	$25.31	$49.96 2/		$24.65

1/ 11 applications per season.

2/ Weighted average is derived assuming 30% of treatments would be with chlorothalonil and 70% of treatments with captafol.

Conclusion: Yields and quality of sweet corn in Florida can be maintained with chlorothalonil and captafol. Season chemical cost would double.

EXTENT OF USE: In Florida 58,000 of 60,000 planted acres of sweet corn are treated with EBDC fungicides (maneb, mancozeb, zineb, or metiram). Applications are made at 1.2 lb./acre (a.i.) an average of 11.1 times per season for a total of 775,000 lb. (a.i.).

ECONOMIC IMPACTS:

User: Users could replace EBDC's with chlorothalonil or difolatan and maintain disease control. The treatment schedule would remain the same. The season treatment cost would increase by $24.65/acre when using the alternatives. Under current market conditions the cost increase would absorb 7-20% of net revenues. Should EBDC's be cancelled on lettuce, current lettuce acreage in Florida would shift into sweet corn production, thereby lowering prices to the point that sweet corn production may not be profitable in some areas.

Market/Consumer: Taken in isolation, cancellation of EBDC's on sweet corn would have minimal impacts on production, quality or prices at the retail level. It is expected however that acreage currently planted to lettuce in Florida could be shifted into sweet corn production. The impact would be to increase the quantity of sweet corn available to consumers by as much as 2.4% for the total U.S. The price of sweet corn then would be expected to decline by about 11%. Gross receipts at the farm level would decline about $10 million for the total U.S. and about $5.4 million in Florida. At the retail level total expenditures by U.S. consumers would decline by $16 million.

Macroeconomic: None expected.

SOCIAL/COMMUNITY IMPACTS: Not investigated.

LIMITATIONS OF ANALYSIS:

1. Usage estimates were made by Assessment Team members. Survey data were not available.
2. Market impacts are based on supply and demand elasticities which may not be representative under the conditions of a cancellation of the EBDC fungicides.

PRINCIPAL ANALYSTS:

John Bratland, USDA
Gary Ballard, EPA
December, 1978

Sweet Corn

User Impact

• The actual annual average production of sweet corn in Florida over the period 1975-77 was approximately 5.1 thousand cwt. (2) Over this period Florida accounted for approximately 37.5 percent of the U.S. production of this crop (Table II-10). However, in 1977 sweet corn production in Florida was significantly below the average annual production for this State. The drop in production in Florida was primarily the result of a frost that destroyed most of the winter crop in 1977. In this assessment, an adjustment will be made to take account of the loss in the 1977 winter crop. In deriving estimates of average annual production, average annual value of production and the average annual price, the assumption is made that the 1976 yield per acre would have been obtained on the 12,500 acres planted in Florida in the winter of 1977. Also, the assumption will be made that this winter crop would have sold for approximately the same price per cwt. (hundred weight) as the 1976 winter crop. With these assumptions, the three averages mentioned above will be adjusted averages when calculated for the period 1975-77. Thus the average annual adjusted production for Florida during this period is 5,520 thousand cwt. (Table II-10). The Florida production was 38.8 percent of the total U.S. average annual adjusted production as shown in Table II-10. The table also shows that 97 percent of the Florida sweet corn acreage is treated with the EBDC fungicides. Thus, approximately 37.6 percent of adjusted U.S. production of sweet corn will be affected by a cancellation on these fungicides.

The major diseases that affect this crop are Northern leaf blight, Southern leaf blight and corn rust. (1) The EBDC fungicides are used in Florida for control of the leaf blights and corn rust. (1)

Alternative Control Programs

If the EBDC fungicides were cancelled for use on sweet corn, Florida growers would turn to two alternatives. These alternatives would be captafol and chlorothalonil: Captafol would be used on 70 percent of the Florida acreage and chlorothalonil would be used on the remaining 30 percent (Table II-11).

The quantity of each alternative used would differ somewhat from the amounts of the EBDC fungicides applied during a growing season. The EBDC fungicides would be applied at a rate that would result in 13.3 pounds of active ingredient being used during the growing season. It would be applied with an average of 11.1 applications with 1.2 pounds of active ingredient applied in each application (Table II-11).

The same number of applications would apply to the alternatives, captafol and chlorothalonil. However, the total quantity of captafol that would be applied during the season would be 16.7 lbs.(a.i.) Chlorothalonil would be applied in a total quantity of 12.5 lbs. (a.i.) per season (Table II-11).

Apparently the use of these alternative fungicides would permit the same level of conrol of the releveant diseases as that attained with the EBDC fungicides. There would be no loss in yield or reduction in grade.

Impact on Production Costs

The increase in production cost per acre for Florida can be expressed as a weighted average. This weighted average shown in Table II-11

would take account of the proportion of the acreage on which chlorothalonil would be used (30 percent) and the proportion on which captafol would be used. Footnote 6 in Table II-11 shows how the cost of $49.96 was derived. This dollar figure represents the weighted average outlay for alternative materials that would be incurred by Florida growers after cancellation of EBDC's. As indicated above, this cost would apply to 97 percent of the acreage in the State (Table II-11). This increase in material costs would be approximately 3.0 percent of the average annual adjusted total revenue per acre over the period 1975-1977 (Table II-11). Application costs would be the same with the use of the alternative fungicides.

The same theory, rationale and assumptions as were used in the analysis of U.S. fresh market tomato prices will be employed here to estimate percentage change in production cost (see pages 11-12 and the Appendix to the vegetable section). Thus, the average estimated average resource cost per acre per annum in Florida is $830.00 over the period 1975-1977. Thus, an increase in material cost of $24.65 would represent a 3.0 percent estimated increase in cost per acre (and cost per cwt.) in the State of Florida (Table II-12b). To estimate the impact of this cost increase in Florida on the U.S. price of sweet corn would necessitate weighting the percentage increase in cost by the proportion of total U.S. production affected by this cost increase. Table II-12b shows that the proportion of U.S. production affected is 0.376. Thus, the average cost increase per cwt. for total U.S. production of sweet corn would be approximately 1.13 percent (Table II-12b).

Changes in Yield Quality and Production

The cancellation of EBDC's and the substitution of alternatives discussed above would not involve any loss in yield or change in quality. To this extent, production levels on acreage currently allocated to corn production would be maintained. However, sweet corn acreage in Florida would be expanded in spite of the cost increase imposed on sweet corn growers by an EBDC cancellation. This expansion in sweet corn acreage occurs because the cancellation of use of EBDC fungicides on lettuce would force lettuce growers into the production of sweet corn. 9/ The average annual lettuce acreage in Florida is approximately 9,933 acres. The assumption is made that this lettuce acreage would maintain the same yield levels in corn production as the acreage currently committed to this crop. If all 9,933 acreas of lettuce in Florida were to shift into sweet corn, production of this commodity would increase by 1,013,166 cwt. This estimate is based on the assumption that all of the acreage shift will occur in the Everglade area in Florida. Over the period 1975-77, the yield per acre in this part of Florida was 102 cwt. per acre (7,8). The increase in sweet corn acreage in Florida would result in a significant percentage increase in Florida production of this commodity. Also, since Florida's share of total U.S. production is large, the increase would also mean an important percentage increase in total U.S. production. 10/

9/ For details concerning the extent and nature of the impact of an EBDC cancellation on lettuce production, see the section on lettuce.

10/ Florida's share in total U.S. production in shown in Table II-10.

As noted above, the adjusted average annual production calculated for Florida is 5,520 thousand cwt. (Table II-10). The adjusted average annual production for the entire United States period 1975 through 1977 is 14,202 thousand cwt. 11/ An increase in Florida production of 1,013,166 CWT would constitute a 18.4 percent increase. The adjusted average is the 5,520 thousand cwt. shown in Table II-10. This production increase in Florida would be a 7.1 percent increase in the adjusted average annual production for the United States.

Changes in Commodity Price and Farm Income

The impact of the cost increase and the acreage increase on the price of sweet corn will depend upon the magnitude of these increases and upon the elasticities of supply and demand. For the pruposes of this assessment, an estimated value of -0.22 will be used as the price elasticity of demand for sweet corn. 12/ The elasticity of supply that will used in this assessment is 0.4 13/

11/ The data used in making these calculations are found in Vegetables 1977 Annual Summary, Acreage, Yield, Production and Value, Crop Reporting Board, USDA. December 23, 1977.

12/ This elasticity is derived by P.S. George and G.A. King in Consumer Demand for Food Commodities in the United States with Projections for 1980, Giannini Foundation Monograph Number 26, March 1971. This number is estimated from an elasticity which applies to a group of commodities titled "other fresh vegetables" in the George and King study. The elasticity -0.22 is the product of the retail level elasticity of demand -0.32 and the average elasticity of price transmission for 5 fresh market vegetables. The average elasticity of price transmission for the 5 vegetables is 0.69.

13/ The elasticity of 0.4 applies to a larger group of commodities classified as "vegetables." This elasticity is cited in Luther Tweeten's book, The Foundations of Farm Policy, University of Nebraska Press, 1970.

The base price to be used in this assessment is a three year average price based on the period 1975-77. The average price must take account of the adjustment described earlier with respect to the 1977 winter crop in Florida. Earlier an estimate was made of the 1977 winter crop that would have been produced if the frost had not occurred and if the 1976 winter yield had been obtained by making the assumption that the price per cwt. for 1976 crop would also have been obtained in 1977. The value of the crop would have been $13.64 million instead of the actual $3.2 million. If the former value were used in calculating an average annual value of production in Florida and in the U.S. for the period 1975-77, the estimates obtained are $49,899 thousand for Florida and $117,508 thousand for the U.S.

The average annual adjusted price per cwt. for the period 1975-77 was $9.04 in Florida and $8.27 for the U.S. a whole. These are the average prices that would have emerged if yield on the 12,500 acres planted for the winter crop of 1977 had maintained the 1976 yield and if this crop had been valued on the basis of 1976 winter crop prices.

The desired estimate of price impact is that which would apply to the U.S. as a whole. As outlined above, there are two forces that would affect the price of sweet corn. The first would be the increase in cost per cwt. because more expensive fungicides would be used after a cancellation of the EBDC fungicides. This increase in cost would impose an upward pressure on the farm level price of sweet corn. Second, the increase in sweet corn acreage in Florida will have the definite effect of forcing sweet corn prices downward in the State and in the U.S. as a whole. The estimated net effect of these influences would be a

downward adjustment in the average U.S. price of 10.7 percent. 14/

14/ This estimate would be obtained through the use of the following formula:

$$\% \text{ change in price} = \frac{(\text{elasticity supply})\ (\%\text{ inc. in ave. cost}) - (\%\text{ supply inc.})}{(\text{elasticity of demand}) + (\text{elasticity of supply})}$$

% change in price = 10.72

Elasticity of supply = 0.4 — This elasticity applies to a larger group of commodities classified as "vegetable". This elasticity is cited in Luther Tweeten's book Foundations of Farm Policy University of Nebraska Press, 1970.

Elasticity of demand = 0.22 — (absolute value): This elasticity was derived from P.S. George and G.A in Consumer Demand for Food Commodities in the United States with Projections for 1980. Giannin; Foundation Monograph No. 26, March 1971. This elasticity is a product of the retail level price elasticity of demand, 0.32, and the average elasticity of price transmission for 5 fresh market vegetables. The average elasticity of price transmission for these vegetable is about 0.69.

Weighted percent increase in U.S. production costs = 1.13

Weighted percent increase in the U.S. supply of sweet corn = 7.1

The formula used above is obtained from two formulas developed in the Appendix to the vegetable section. One formula would permit estimation of percentage increase in price resulting from an increase in production cost. The other formula permits the estimation of percentage price change resulting from a change in U.S. supply. The formula in this footnote is merely an algebraie sum of the right hand side of both formulas.

Since the estimated increase in price is greater than one percent, an estimation will be made of the change in total revenue accruing to farmers. This approach is in accordance with the procedure specified in the Introduction to the vegetable section.

The average annual adjusted value of production for the period 1975-77 would have been $117,508 thousand for the entire U.S. The average annual adjusted production for this period 1975-77 would have been 14,202 thousand cwt. The adjusted price for this period is $8.27 per cwt. A 10.7 percent reduction would lower this adjusted price to $7.39 per cwt. Since the farm level price elasticity used in this assessment is equal to 0.22, the expected increase in the quantity marketed would be 2.4 percent. This percentage would represent the increase in the quantity marketed once there is an adjustment to the reduced price as the farm level. 15/ The average annual quantity marketed would increase from the adjusted level of 14,202 thousand cwt. to 14,543 thousand cwt. At an average annual price of $7.39 per cwt. this latter quantity would generate a total gross revenue of $107,473 thousand for all sweet corn growers in the U.S. The total reduction in gross receipts on all U.S. sweet corn production would be about $10 million.

15/ Some clarification may be necessary concerning the difference between the 7.1 percent increase in supply that occurs because of the acreage increase in Florida and the 2.4 percent increase that would finally occur after adjustment to the price decrease. The former represents the initial impact of the cancellation on EBDC fungicides. It does not take account of the fact that prices will tend to fall as a result of the initial impact of a supply increase. The explicit assumption will be made that adjustment from a 7.1 percent increase in supply to a 2.4 percent increase will affect acreage in all States that grow sweet corn. This assumption permits the corollary assumption that most of the 9,933 additional acres committed to sweet corn production in Florida will remain in sweet corn after the reduction the market price.

The impact on Florida must take account of the reduction in receipts incurred on the acreage already in sweet corn production at the time that EBDC's are cancelled. The assumption is made that no loss in yield would be incurred in switching from EBDC fungicides to chlorothalonil or captafol. On the acreage already committed the production of sweet corn, the same level of average annual adjusted production shown in Table II-10 is assumed to hold in the event that the EBDC fungicides are cancelled. The reduction in gross receipts would result from the decrease in Florida. A reduction of 10.7 percent would lower the price in Florida from the average annual adjusted price of $9.04 to $8.07. This reduction would reduce the average annual gross receipts from $49,899 thousand to $44,546 thousand on the average annual acreage currently committed to sweet corn production. Gross receipts for Florida growers would be reduced by approximately $5.4 million. This dollar loss in receipts would represent the estimated loss in gross income to growers already in sweet corn production.

The reduction in price would have a significant effect on gross receipts per acre in Florida. The adjusted gross revenue per acre for the period 1975-77 was approximately $830.00. A cancellation on the EBDC fungicides would reduce the gross revenue per acre to $741.

Impact on Returns

Production cost information is available for three major producing areas in Florida. These areas are the Central Florida area, the Everglades and the Lower East Coast. Table II-12 shows production cost information

for these three areas in Florida (7,8). The information on revenue per acre in the three areas derived from two different sources. First, the information on yield is derived from the production budgets cited in the preceding footnote. The yield per acre is multiplied by the average annual adjusted price derived for Florida. The average annual adjusted price for the period 1975-77 is $9.04. The explicit assumption is made that all producers of sweet corn in these areas received a price per cwt approximately equal to this average annual adjusted value. At this price per cwt., the total receipts per acre are $1319.84 for Central Florida, $922.08 for the Everglades and $967.28 for the Lower East Coast. Estimates of the net returns per acre are shown based on the assumption that growers receive the price mentioned above. These estimates are $360.17 for Central Florida, $149.44 for the Everglades, and $122.85 for the Lower East Coast area.

As noted above, the net effect of the cost increase for materials and the increase in sweet corn production in Florida would be to lower the price of sweet corn by 10.7 percent. A cancellation of EBDC fungicides on vegetable crops would lower the price of sweet corn from $9.04 to $8.07 per cwt. At this lower price, the total revenue per acre would be $1,178.22 in Central Florida, $823.14 in the Everglades and $863.49 in the Lower East Coast area. With the added cost of $24.65 for alternative fungicides, the net revenue per acre in the three areas would fall

$193.90 in Central Florida, $24.85 in the Everglades and $-5.59 in the Lower East Coast area. Table II-12 shows that the reductions in net return per acre in each of the three areas is at least $125.00 per acre. What effect will these reductions have on the acreage allocated to sweet corn in Florida? Those most knowledgeable concerning vegetable production in Florida are of the view that the above described losses in net return per acre in each of the three areas is at least $125.00 per acre. What effect will these reductions have on the acreage allocated to sweet corn in Florida? Those most knowledgeable concerning vegetable production in Florida are of the view that the above described losses in net revenue would not alter acreage allocation beyond that which would be induced by the initial cancellation of the EBDC fungicides (9). The EBDC cancellation itself would shift acreage out of lettuce production into sweet corn production. However, no major shift of sweet corn acreage would be expected after the change in price of sweet corn and the cost increase imposed by the necessary use of a more expensive alternative fungicide . 16/

Consumer Impact

Changes in Qualtity and Quality of the Production Available

The use of the alternative fungicides captafol and chlorothalonil would not result in any reduction in the quality of sweet corn produced in Florida.

16/ In the view of Dr. Donald Brooke, a net loss per acre would be substained by growers for a least three years before a major shift out of sweet corn production were to occur.

Consumers would be availed of larger quantities of sweet corn because of the change in acreage that would occur in Florida. As noted above, the estimated increase in sweet corn production that would occur because of this acreage shift would be approximately 1,013.2 thousand cwt. This additional output would represent approximately a 7.1 percent increase in the quantities of this commodity currently available to consumers.

Change in Consumer Expenditures

The total expenditure made by all U.S. consumers of sweet corn would be expected to decline because of reduction in price. 17/ For the U.S. as whole, the cancellation of use of the EBDC fungicides would increase the total quantity marketed from the 14,202 thousand cwt. to 14,543 thousand cwt. The price at the farm level would fall from the $8.27 per cwt. to $7.39. It is estimated that the growers share of the retail level price is 39 percent. (3) The implied initial retail price would be approximately $21.21 per cwt. If the elasticity of price transmission is 0.69, the average retail level price per one hundred pounds would fall to $19.61.

17/ The increase in expenditure would also hinge on the fact that the elasticity of demand used in this assessment is 0.32. This is a retail elasticity derived by P.S. George and G.A. King in the study cited earlier. It is an elasticity measured for a category of commodities titled "Other Fresh Vegetables." This elasticity will be used as a proxy for the sweet corn elasticity of demand.

The estimated retail level expenditure on 14,202 thousand cwt. would be $301.2 million. This estimate is based on the assumption that the initial retail price is $21.21. The total expenditure would fall on sweet corn by $16 million. This amount would represent a gain to consumers since it represents total purchase of a large total quantity of the commodity.

Summary of Total Losses and Gains

For the U.S. as whole, the net impact of an EBDC cancellation on consumers would be positive. The negative impact on producers would be represented by a 10 million dollar reduction in gross receipts for the entire U.S. The reduction in gross receipts for Florida growers would amount to $5.4 million of the total for the U.S.

The positive impact on consumers is manifested in the fact that a significally larger quantity of sweet corn is available at a lower price. As a result, U.S. consumers would spend about $16 million less on this commodity.

Table II-10 Acreage and Production Affected - Sweet Corn

State	Average acres planted 1975-1977 1/	Percent acres treated EBDC 1976 2/	Expected annual acres treated with EBDC	Average annual adjusted production 1975-1977 (1000 CWT) 3/	Percent of average adjusted U.S. production 1975-77 4/	Percent of U.S. production treated in the State
Florida	60,133	97	58,329	5,520	38.8	37.6

1/ Vegetables 1977 Annual Summary Crop Reporting Board, USDA

2/ Assessment of EBDC Fungicide Uses in Agriculture Part II USDA/State/EPA Assessment Team April, 1978

3/ Source: Vegetables 1977 Annual Summary. The average annual adjusted production takes account of the fact the 1977 winter crop was destroyed by inelement weather conditions. An adjustment is made to account for the fact 1977 production for Florida does not reflect "normal" production levels for the state. The assumption is made that if the frost had not occurred, the yield per acre on the 12,500 acres planted in Florida in the winter of 1977 would have been the same as the that for the 1976 winter crop. This adjustment will result in an adjusted estimate for the year 1977 and also for the annual average derived for the period 1975-1977.

4/ The average annual adjusted production for the U.S. for 1975-77 takes account of the adjustment mentioned in the preceding footnote.

Table II-11 . Treatment cost per acre and total - sweet corn

State	Average number of EBDC applications per acre 1/	Pounds active ingredient applied per acre per application 2/	Estimated EBDC A.I. applied per acre per season	Estimated materials cost per acre with EBDC 3/	Estimated quantity of preferred alternative used per acre season (units A.I.) 4/		Estimated materials cost per acre with the preferred alternatives 5/	Difference in material cost per acre with alternative-Average	Total cost impact for the state (1,000 dol.) 6/
					Chlorothalonil	Captafol			
Florida	11.1	1.2	13.3	25.31	12.5	16.7	49.96	24.65	1,437.8

1/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978. The specific EBDC fungicide used is Zineb.

2/ Ibid.

3/ The estimated price of the EBDC fungicides is about $1.90 per lb. a.i. The estimated price of EBDC is an average from several price lists.

4/ If the EBDC fungicides were suspended, Chlorothalonil would be used in 30 percent of applied acres and captafol would be used on 70 percent of the affected acreage. Source: Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978.

5/ The dollar figure given is a weighted average based on the proportion of acres treated with each fungicide: 49.96 - (12.5) (4.75) (.3) + (2.75) (.7) (16.7). The estimated average price for Chlorothalonil is $4.75. The estimated average price for Captafol is $2.75. Both are averages derived from several price lists.

6/ This estimate represents the total added outlay that would be incurred on the 58,329 acres already treated (Table II-10). The estimate is the arithmetic product of the acres treated and the difference in material cost per acre with the alternative fungicide.

Table II-12. Sweet corn

Cost, Price Revenue Information for Sweet Corn Production in Florida in 3 Major Producing Areas, 1975-77 Averages

Item	Central Florida	Everglades	Lower East Coast
1975-76 Acreage 1/	4023	15960	6300
1976-77 Average 2/	3234	12351	7406
Growing Cost 3/	433.29	364.37	429.86
Harvesting and Marketing Cost 4/	526.38	408.27	414.57
Total Crop Costs 5/	959.67	772.64	844.43
Average Yield Per Acre on Acreage Sampled			
Crates 6/	292	203	214
CWT 7/	146	102	107
Average Price Per CWT 1975-77 (Florida) 8/	9.04	9.04	9.04
Estimated Price per CWT After an EBDC Ban 9/	8.07	8.07	8.07
Estimated Total Revenue Per Acre At 9.04 Per CWT	1319.84	922.08	967.28
Estimated Net Revenue Per Acre Prior to An EBDC Ban	360.17	149.44	122.85
Estimated Total Revenue Per Acre at 8.07 Per CWT	1178.22	823.14	863.49
Estimated Additional Cost Per Acre For The Alternative Fungicide 10/	24.65	24.65	24.65
Estimated Net Revenue Per Acre After An EBDC Ban	193.90	24.85	-5.59

1/ Source: D. L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1975-76 With Comparisons Food and Resource Economics Department, University of Florida, Gainesville, March 1977.

2/ Source: D.L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 With Comparisons Food and Resource Economics Department, University of Florida, Gainesville, March, 1978.

3/ The amounts shown are weighted averages of data in the D.L. Brooke publication cited above. The weights are determined by the acreage proportions within the region for each of the two time periods.

4/ The amounts are weighted averages with weights determined in the same manner as that described in footnote 3. However, the average for The Lower East Coast is derived in somewhat different manner. The weighted average harvest cost per crate was derived instead of harvest cost per acre. This weighted average harvest cost per crate was multiplied by the yield per acre in the 1975-1976 period. This procedure was necessary because the yield in the period 1976-77 did not reflect average production levels for the area in Florida.

5/ These are weighted averages derived in the same manner as that described in footnote 3 above.

6/ See the preceding footnote.

7/ The assumption is made that a crate of sweet corn weights approximately 50 lbs.This estimate of weight is found in Agricultural Statistics 1977 U.S. Department of Agricultural.

8/ This is an adjusted average annual price for the period 1975-77. The average is derived from data found in Vegetables 1977 Annual Summary Acreage, Yield, Production and Value Crop Reporting Board, USDA, December 23, 77.

9/ This price would reflect the 10.7 percent reduction in price resulting from expanded production in Florida.

10/ This estimate is derived through the process of averaging the price of the EDBC fungicides from several price lists. The prices of the alternatives are also averaged from several price lists. Estimates of quantities used per acre are provided by members of the EDBC Assessment Team.

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF
CANCELLING EBDC USE ON CUCURBIT CROPS

A. USE: EBDC use on commercially produced cucurbit production

B. MAJOR DISEASES CONTROLLED: Downy mildew, gummy stem blight, and target spot

C. ALTERNATIVES:

Major registered chemicals: Chlorothalonil, Captafol, Benomyl (RPAR)

State recommendations:

Number of States Recommending* for Diseases

	Downy Mildew	Gummy Stem Blight	Target Spot
EBDC	22	10	2
Chlorothalonil	16	12	2
Captafol	11	8	2
Benomyl	0	13	0
No alter. recommended	3	0	2
			0

* These recommendations are for cucumber, the other cucurbits follow a similar pattern.

Non-chemical controls: Effective non-chemical controls are not available.

Efficacy of alternatives: Chlorothalonil would replace EBDC's on most cucurbit acreage. Chlorothalonil is considered to be equivalent to EBDC in disease control. Captafol would be used on about one-half of the cantaloup acreage in Texas and is considered to give equivalent control.

Comparative performance: Yields and quality would be maintained by use of chlorothalonil and captafol in place of EBDC.

Comparative costs: Use of alternatives would increase chemical and hence production costs over a range from $9.98/acre for watermelon in Texas to $46.93/acre for squash in Florida. In relative terms this cost increases equal 2.6% - 11.9% of revenue for watermelon, 3.5% - 7.5% of revenue for fresh cucumbers, 4.5% - 8.1% of revenue for pickling cucumbers, 1.3% of revenue for cantaloup, and 5.1% of revenue for squash.

Conclusion: Chlorothalonil and captafol could replace EBDC and provide effective disease control in cucurbits. Chemical costs and hence total production costs would rise significantly.

EXTENT OF USE:

Active ingredient basis: 1.6 million pounds. Primarily applied in southeast but significant quantities also used in Texas and Michigan.

Units treated basis: Approximately 184,500 acres of cucurbit crops are treated annually with EBDC.

ECONOMIC IMPACTS:

User: Production costs would rise by an average of 1.5% to 11.9% of gross revenue for cucurbit producers. Net revenues would be significantly reduced especially for growers in Florida and Mississippi. Net revenues should remain high enough so that there would be minimal exits from cucurbit production.

Market: Quality and yields would be maintained for all cucurbit crops. Production of watermelons could decline 0.4% because of increased production cost induced price rise. Other cucurbit production levels are expected to be maintained.

Consumer: Retail price of watermelon would increase an estimated 1.16%. Quantity of watermelon market would decline 0.4% and result in net additional outlays of $1.0 million. Impacts for other cucurbits are not expected to be significant.

Macroeconomic: None expected.

SOCIAL/COMMUNITY IMPACTS: Not investigated.

LIMITATIONS OF ANALYSIS: Estimates of EBDC use were provided by Assessment Team members. User survey data were not available.

PRINCIPAL ANALYST AND DATE:

John Bratland, USDA
Gary Ballard, EPA
September 1978

ECONOMIC ANALYSIS OF THE IMPACT ON AN EBDC BAN ON THE CUCURBIT CROPS

WATERMELON

User Impact

The cucurbits group includes mainly four commodities that will be addressed in this assessment. These are watermelon, cucumbers (fresh market and for pickles), cantaloupes and squash. These crops are grown mainly in the southern States including Texas and Florida. However, Michigan accounts for a major share of cucumber production in the U.S., particularly the cucumbers grown for pickling.

This group of vegetables is affected by a small number of diseases that can reduce yields by as much as 75 percent in some areas. These diseases include down mildew, gummy stem blight and target spot. The EBDC fungicides are effective in the control of all of these diseases on each of the crops in the areas where they are grown.

Six States account for 77.4 percent of U.S. production of watermelons. However, the two major producers, Texas and Florida, account for 55.6 percent of the U.S. production (Table II-13). The remaining States, Georgia, South Carolina, Alabama and Mississippi account for nearly 22 percent of U.S. production. In Florida and Texas, 76 and 55 percent of the planted acreage is treated respectively. Approximately 37 percent of total U.S. production of watermelon is treated with EBDC's in these two States. Table II-13 also shows that 49.9 percent of total U.S. production is treated with the EBDC's in these 6 States.

Similar information for fresh market cucumbers is shown in Table II-16. Florida is shown to be a major producing State for this crop accounting for 38.4 percent of U.S. production. Of the Florida acreage, 83 percent is treated with the EBDC's. Thus, 31.9 percent of U.S. production is shown to be treated in this State. The other three States shown in Table II-16 are North Carolina, South Carolina, and Michigan. These States account for nearly 19 percent of the total U.S. production of fresh market cucumbers. In these three States, 11.2 percent of U.S. fresh market cucumber production is treated with the EBDC's.

The last three States mentioned above as producers of fresh market cucumbers are also producers of cucumbers grown for pickling. As shown in Table II-20, Michigan, North Carolina and South Carolina account for 35.5 percent of total U.S. production of cucumbers grown for pickling. In these States, nearly 18 percent of total U.S. production would be affected by a cancellation of EBDC's.

In the U.S. production of cantaloups, only the acreage in one State would be affected by a cancellation of EBDC fungicides. In the State of Texas 12,425 acres of cantaloups are treated with these fungicides. This acreage accounts for 75 percent of the total in the State (Table II-22). Texas accounts for 16.3 percent of total U.S. production of this crop. Thus, 12.2 percent of U.S. cantaloupe production would be affected by a cancellation of EBDC fungicides (Table II-22).

In squash production, only Florida is dependent on the EBDC fungicides. In this State the average squash acreage over the 1975-77 period was 12,100 acres (Table II-24). Of this total acreage in Florida, 100 percent was treated with the EBDC's. As shown in the table, 1.8 millon bushels of squash are grown on this acreage.

Alternative Control Programs

For each of the crops considered in the cucurbit group, chlorothalonil would dominate as the preferred alternative. In almost all cases, the amount of active ingredient of chlorothalonil applied per acre would differ somewhat from the amount of the EBDC fungicide used. Tables II-14a, II-17a, II-21a, II-23a, and II-25a show the respective rates of fungicide application on watermelon, fresh cucumbers, cucumbers for pickles, cantaloupes and squash.

Table II-23a also shows that captafol would be used on 50 percent of the Texas acreage of cantaloups on which the EBDC fungicides are currently used.

The point should be emphasized that the alternative fungicides, chlorothalonil and captafol would be equally effective against the various diseases mentioned above. For all of the crops in the cucurbit group, the alternative fungicides would result in maintenance of yields.

Impact on Production Cost

Watermelon

Of the six watermelon producing States that would be affected by an EBDC cancellation, Florida would incur the greatest increase in cost per acre. The current material cost outlay per acre per season for the EBDC's is $19.76. The outlay necessary for the alternative material, chlorothalonil would be $57.95. This would represent an additional outlay of $38.19 in this State (Table II-14a). Application costs are the same with the alternative, Georgia, South Carolina, and Alabama would incur roughly equal increases

in material cost per acre. The respective outlays per acre per season for the EBDC fungicides in these States are $18.24, $13.30 and $25.60. After a potential cancellation these States; Georgia, South Carolina, and Alabama, would face roughly equal respective increases in cost per acre season of $24.51, $22.33, and $23.28. In Texas and Mississippi, the current outlay per acre per season for the EBDC fungicides is $$11.40 and $19.00, respectively. A cancellation of the EBDC fungicides would involve additional outlays of $9.98 per acre per season in Texas and $16.63 per acre per season in Mississippi.

Fresh Market Cucumbers

Table II-17 shows that in the four affected States, the range of cost per acre per season for the EBDC fungicides is $13.30 in North Carolina to $18.05 in Florida. The substitution of chlorothalonil (Bravo) for EBDC fungicides would raise the material cost per acre per season on fresh market cucumbers form $37.72 respectively if the preferred alternative must be used in place of EBDC fungicides.

Cucumbers for Pickles

Table II-21a shows the respective costs per acre for EBDC's on cucumbers grown for pickles in the three affected States. In the States of Michigan, North Carolina, and South Carolina the current average outlays per acre per season are $10.26, $13.68 and $11.9, respectively. If the EBDC fungicides were cancelled and replaced with the chlorothalonil, the respective increases in material cost per acre per season in Michigan, North Carolina, and South Carolina would be $27.80, 29.07 and $20.09.

Cantaloupes

For this crop, Texas would be the sole State affected by a cancellation of the use of the EBDC fungicides. Currently, the average chemical cost per acre per season for the EBDC's in Texas is $17.10 (Table II-23a). As indicated earlier, the EBDC fungicides would be replaced with two alternative fungicides if the former pesticides were cancelled. Captafol would be used on 50 percent of the acreage currently treated with the EBDC's in Texas and chlorothalonil would be used on the other 50 percent of the Texas acreage. The average increase in chemical cost per season that would be incurred with these alternative materials would be $20.27. This increase would be weighted by the proportion of the respective acreage that would be treated with each material and the cost of each material ($4.75 per lb. (a.i.) for chlorothalonil and $2.75 per lb. (a.i.) per captaforl). The rates of application are the same for both chemicals.

Squash

For squash production, Florida would be the only State affected by a potential cancellation of the EBDC group of fungicides. The current chemical cost per acre per season for the EBDC fungicides on squash is about $24.32 per acres (Table II-25a). A replacement of EBDC's with the preferred alternative, chlorothalonil would involve an extra chemical cost of $46.93 per acre per season. The application cost would be the same with the alternative (Table II-25a).

Changes in Yield, Quality, Production

In the case of all of the crops in the cucurbit group, yield levels and grade would be maintained if growers were forced to use the alternatives

indicated above. No significant adjustments in production would be expected from this change.

Changes in Commodity Prices and Farm Income

The average U.S. prices of the cucurbit commodities would be affected to varying minimal degrees by cancellation on the use of EBDC fungicides. The extent of the increased price would be determined by several considerations. These would include:

(1) The proportion of total U.S. production affected by the cancellation

(2) The weighted percentage increase in production cost for total U.S production of the respective commodities,

(3) The responsiveness of quantities demanded of each commodity to price changes (elasticity of demand) and,

(4) The responsiveness of quantities supplied to changes in the price of the commodity (elasticity of supply).

The same theory, rationale and assumptions as were used in the analysis of U.S. fresh market tomato prices will be employed to estimate percentage change in average production cost (see the Appendix to the vegetable section). For each commodity in the cucurbit crops, average revenue per acre over the period 1975-77 is used in the analysis to approximate long-run average production cost per acre.

Watermelon

The estimates of average cost per acre in the 6 affected States would range $568 on watermelon acre in Georgia to $140 on such acreage in Mississippi (Table II-14b). The estimated percent increase in production cost would range from 11.9 percent in Mississippi to 2.6

percent in Texas. In Table II-14b, each of the percent increase in production cost is weighted by the proportion shown in the first column of Table II-14b. The resulting arithmetic product is the estimated weighted percent impact on U.S. average production cost originating in the respective States. The percentages are shown in the righmost column of Table II-14b. The sum of the weighted percentages is 3.0 percent. This percentage represents the weighted percent change in average U.S. production cost of the commodity that would result from an EBDC cancellation.

This estimated percentage increase in total production cost per cwt can be used to make an estimate of the percentage change in price per cwt. However, information on cost changes must be combined with estimates of price elasticities to derive estimates of percentage change in price. The estimate of the price elasticity of demand for watermelons that will be used here is -0.32. 18/ The price elasticity of supply that will be used here is 0.23 (14). The estimate of the percentage increase in the price of watermelons that emerges from this information is 1.26 percent. 19/

18/ This number is an elasticity derived by P.S. George and G.A King in Consumer Demand for Food Commodities in the United States with Projections for 1980, Giannini Foundation Monograph number 26, March 1971. This elasticity is an estimate of the price elasticity of demand for a group of commodities classified as "other fresh vegetables."

19/ This estimate would be obtained through the use of the following formula:

$$\% \text{ Change in price} = \frac{(\% \text{ change in cost})\ (\text{supply elasticity})}{(\text{supply elasticity} + \text{demand elasticity})} = 1.26\%$$

% Change in cost = 3.0 %
Supply elasticity = 0.23
Demand elasticity = 0.32 (absolute value)
See the Appendix for further information on the appropriate use of the formula and the assumptions inherent in its use.

Since the estimated increase in price exceeds one percent, an estimate will be derived of the increase in the total revenue that accrues to growers because of the price increase. This procedure is in accordance with the methodology outlined in the Introduction to the vegetable section. The average annual U.S. weighted price for watermelon over the period 1975-77 was $3.54 per cwt. An increase in average annual price of 1.26 percent would increase this price to $3.58. The percentage change in the quantity of watermelon marketed would be equal to the arithmetic product of the price elasticity, 0.32 and the estimated change in price, 1.26 percent. This percentage reduction in quantity sold would be 0.4 percent.

The average annual quantity of watermelon sold over the period 1975-77 was 25,395 thousand cwt. A reduction of 0.4 percent would mean that the average quantity sold would be approximately 25,293 thousand cwt. At the increased price $3.58 per cwt, this quantity sold would generate total annual revenue for U.S. watermelon growers of $90,548,940. Over the period 1975-1977, the total annual revenue that accrued to U.S. watermelon growers was $89,799,000. Thus, a price increase of 1.26 percent for watermelons would increase the total revenue accruing to U.S. growers by $749,940.

An estimate of the increase in total revenue that would accrue to growers in the respective affected States must take account of differences in the prices at which watermelons are marketed in these States. The following listing shows the average prices that were received by farmers over the period 1975-1977. The list also shows the estimated price that would be received by growers in these States after a cancellation on EBDC use.

	Weighted average annual price per cwt. 1975-77 (2)	Estimated average price per cwt after a cancellation on the use of EBDC
	dols.	dols.
Florida	3.25	3.29
Texas	4.23	4.28
Georgia	8.14	8.24
South Carolina	7.01	7.10
Alabama	3.62	3.67
Mississippi	2.38	2.41

The estimates in the above listing are made under the assumption that the prices in each of the affected States would increase by the same estimated percentage as the price for the total U.S., -1.26 percent.

A 0.4 percent reduction in the quantity marketed in each affected State would result in an increased level of total revenue to growers in the respective States. The following list shows the average annual value of watermelons sold in the respective States over the period 1975-1977. The column on the right shows the estimated annual revenue that would accrue to growers in each State after a cancellation on EBDC's

State	Value of production 1975-77 (20)	Estimated value of production after a cancellation on EBDC use
	1000 dollars	1000 dollars
Florida	29,146.0	29,373.6
Texas	21,786.5	21,958.1
Georgia	19,634.1	19,795.4
South Carolina	9,328.0	9,412.3
Alabama	3,772.9	3,805.2
Mississippi	1,792.0	1,807.5

The estimates in the right column are based on the assumption of a 1.26 percent increase in the price of watermelons at the farm level in each of the affected States.

The net gains or losses that would be incurred in each of the affected states would be the difference between the aggregated additional outlay for alternative fungicides and the change in the value production that would occur because of a price increase. These net losses are given for each of the affected states in the following listing

20/ These data are derived by multiplying the revenue per acre in Table II-14a times the planted acres in Table II-13. Thus the numbers will differ somewhat from the Crop Reporting Board estimates.

State	Gains from change in the value of production	Losses from increase in material cost	Net losses in each affected State
	1000 dollars	1000 dollars (Table II-14a)	
Florida	227.6	1,712.4	1,484.8
Texas	171.6	314.7	143.1
Georgia	161.3	559.2	397.7
South Carolina	84.3	393.0	308.7
Alabama	32.3	44.1	11.8
Mississippi	15.5	61.7	46.3
Total	692.6	3,085.1	2,392.5

The amount $2,392.5 would represent the net loss that would be incurred by growers in all of the affected States. However, it would not represent the net losses for the U.S. as a whole. The increase in the value of production (or total revenue received by growers) for the U.S. as a whole was found to be $749.6 thousand. This increase would occur because of the increase of 1.26 percent in the U.S. price of watermelons. Of this U.S. total an estimated $692.6 thousand would be accounted for by price changes in the affected States. Thus, an estimated $57.0 thousand in addtional revenue would accrue to growers outside the affected States. For the U.S. as a whole, the estimated net loss measured by growers because of an EBDC cancellation would be $2,235.5.

Fresh Market Cucumbers

The methodology employed above to estimate the percentage change in the price of watermelon will be employed in estimating the percentage increase in the price of fresh market cucumbers.

Estimates of average cost per acre in the 4 affected States would range from \$1184 in Florida to \$418 in North Carolina (Table II-17b). The estimated percent increase in production cost ranges from 7.5 in North Carolina to 3.5 in Florida. Each percent increase in production cost for the respective States can be weighted by the proportion of U.S. production treated in the State. Each of these proportions are shown in the leftmost column of Table II-17b. The sum of the weighted percentage, 1.63, represents the change in average U.S. production cost of fresh market cucumbers that would result from an EBDC cancellation.

The estimate of the percentage change in price for fresh market cucumbers would be derived directly from the above estimate of the cost increase per cwt. The price elasticity of demand for fresh market cucumbers is estimated to be -0.198. (3) This price elasticity of supply is estimated to be 0.1902 for fresh market cucumbers. (4) With the use of both price elasticities and the estimate of the percentage increase in production cost per cwt, one can obtain the estimate of the percentage change in price that would be induced by a cancellation on the use of the EBDC fungicides. This estimated increase in price is 0.80. 21/

21/ The estimate would be obtained through the use of the following formula:

$$\%\text{ change in price} = \frac{(\%\text{ change in cost})\ (\text{supply elasticity})}{(\text{supply elasticity}) + (\text{demand elasticity})} = 0.8\ \%$$

% change in cost = 1.63%
Supply elasticity = 1.190
Demand elasticity = 1.198
See the Appendix for further information on the appropriate use of the formula and the assumptions inherent in its use.

Since the estimated increase in price per cwt for fresh market cucumbers is less than one percent, no attempt will be made to assess the increase in revenue that would accrue to growers because of the increase in price.

The estimated losses would be an arithmetic product of the increase in material cost per acre in each State and the average annual acres treated in the respective States. Table II-17a shows that the losses would range from $544.3 thousand in Florida to $46.8 thousand in Michigan. The total losses for the four affected states is $806.2 thousand.

Cucumbers for Pickles

Estimates of change in price require information on production cost. Average cost estimates for the 3 affected States are $484 for Michigan, $358 for North Carolina, and $338 for South Carolina (Table 21b). The estimated percentage changes in production costs are 4.5, 8.1 and 5.9 for the three respective States (Table II-21b). In the table, each percent increase in production cost is weighted by the proportion of U.S. production treated in the respective States. Each of these proportions are shown in the leftmost column of Table II-21b. The sum of the weighted percentages in the rightmost column, 0.99, gives an estimate of the change in average U.S. production cost that would result from a cancellation of the EBDC fungicides.

The extent of the percentage change in price for pickling cucumbers would depend on the extent of the change in cost per ton for the U.S. and on the values of price elasticities of demand and supply. The demand elasticity that will be used for the purposes of this assessment

is -0.4. 22/ The supply elasticity for this commodity is approximately 0.19. 23/ The elasticities permit one to estimate the impact of the change in cost on the price. With the use of this information it is estimated that the percentage increase in the price per ton for pickling cucumbers is approximately 0.32 percent. 24/

The estimated increase in price is less than one percent. Thus, no attempt will be made to estimate the increase in total revenue that would accrue to cucumber growers because of the increase in price.

For each State, the total losses that would be incurred can be estimated by calculating the arithmetic product of the average annual acres treated and the increase in material cost per acre. The estimated losses or added total cost of the three affected States are $354.1 thousand

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22/ This elasticity was derived by P.S. George and G.S. King in Consumer Demand for Food Commodities in the United States with Projections for 1980, Giannini Foundation Monograph Number 26, March 1971. The elasticity was derived for a group of commodities titled "other canned fruits and vegetables." The elasticity is measured at the retail level. It will be assumed that the percentage spread between retail price and farm level prices is constant. Thus the retail price elasticity of demand and the farm level price elasticity of demand would be approximately equal.

23/ This supply elasticity is roughly that used for fresh market cucumbers above. This proxy estimate for the supply elasticity of cucumbers for pickling is thought to be reasonable since nearly all of the States involved in the production of fresh market cucumbers are also producers of cucumbers for pickling.

24/ The estimate is obtained through the use of the following formula:

$$\% \text{ change in price} = \frac{(\% \text{ change in cost})\ (\text{supply elasticity})}{(\text{supply elasticity}) + (\text{demand elasticity})} = 0.3178$$

% change in price = 0.3178
% change in cost = 0.9869
Supply elasticity = 0.19
Demand elasticity = 0.40 (absolute value)

See the Appendix for further information on the appropriate use of the formula and the assumptions inherent in its use.

for Michigan, $252.0 thousand for North Carolina, and $184.2 thousand for South Carolina (Table II-21a). The total for the three affected states is $790.3 thousand (Table II-21a).

Cantaloups

Texas would be the only State affected to any important degree by a cancellation of EBDC fungicide use in cantaloups. The estimated average cost per acre in Texas is $1,351 (Table II-23b). This estimate is based on the average annual revenue per acre for the period 1975-77. The estimated increase in production cost that would be imposed by a cancellation is 1.5 percent (Table II-23b). This percentage weighted by the proportion of U.S. production treated in the State gives an estimate of the weighted percent impact on U.S. average production

It is apparent that such a cost increase would have a small impact on the price of the commodity. Once account is taken of the demand and supply elasticities for cantaloups, it is known that the change in price will be less than 0.183 percent, the estimated change in the average U.S. production cost per cwt. The estimated price elasticity of supply that will be used for this assessment is 0.02. (14) The elasticity of demand that will be used is -0.32. 25/ The change in the price of cantaloups that would be imposed by an EBDC cancellation would be estimated by taking into account the estimated average increase in production cost in the U.S. The elasticity of demand and the elasticity

25/ This elasticity of demand was derived by P.S. George and A.G. King in Consumer Demand for Food Commodities in the United States with Projections for 1980, Giannini Foundation Monograph Number 26, March 1971. This elasticity was estimated for a group of commodities classified as "other fresh vegetables". It is estimated at the retail level. It will be assumed that the percentage spread between the farm level and retail level is constant. Thus, the elasticity -0.32 would be valid for the farm level also.

of supply would be used directly in making this estimate of change in price. The estimate obtained is 0.011 percent 26/. In other words, the price of cantaloups would be changed to a minimal degree by the cost changes that would occur in Texas.

Since the estimated increase in price per cwt. for cantaloups is less than one percent, no attempt will be made to assess the increase in revenue that would accrue to growers because of the increase in price. This procedure is in accordance with the methodology outlined in the Introduction to the vegetable section.

The losses that would be incurred because of a cancellation on the use of EBDC fungicides on cantaloups would be restricted to the State of Texas. An estimate of these losses would be the arithmetic product of the increase in material cost per acre, \$20.27, and the acres of cantaloups treated in Texas, 12,425. The estimate of losses in Texas incurred by cantaloup growers would be approximately \$252 thousand (Table II-23a).

26/ The estimate is obtained through the use of the following formula:

$$\% \text{ change in price} = \frac{(\% \text{ change in cost})\ (\text{supply elasticity})}{(\text{supply elasticity}) + (\text{demand elastiity})} = 0.011$$

% change in cost = 0.18
Supply elasticity = 0.02
Demand elasticity = 0.32

See the Appendix for further information on the appropriate use of the formula and the assumptions inherent in its use.

[illegible] directly in [illegible]

obtained [illegible] 0.011 percent [illegible]. If [illegible] would

[illegible] be changed to [illegible]

be would occur [illegible] Texas.

estimated increase [illegible] price per [illegible]

[illegible], as estimated [illegible] would [illegible]

would [illegible]

is in accordance with [illegible]

the vegetable sector

s that would be imported [illegible]

on consumers [illegible]

losses would [illegible]

[illegible] that not [illegible]

, 13,435. The estimate of losses in Texas prorated by

would be approximately [illegible]

ld be obtained through [illegible] of the following formulas:

1) price = (% change in cost) (supply elasticity [illegible]) [illegible]
supply elasticity [illegible]

= 0.18
= 0.07
0.12

For further information [illegible]
and the [illegible] interest in [illegible].

Squash

All of the squash acreage in Florida is treated with EBDC fungicides as shown in Table II-24. The average annual acreage planted over the period 1975-77 was 12,100. On this acreage, 1.8 million bushels of squash were harvested annually over this period.

The total annual revenue generated per acre in Florida on squash acreage was $927.00 during the years 1975-77. This information is included in Table II-25b along with the added material cost that would be incurred per acre if the EBDC fungicides were cancelled. This increase in cost is $46.93. If the average revenue per acre is used in making an estimate of long-run average resource cost per acre, then the increase in material cost is 5.1 percent increase in average cost. Unfortunately, this estimate of the increase in cost per acre cannot be used to estimate the change in U.S. price of squash that would occur. Such an estimate is not possible because no data are available on the share of total U.S. production accounted for by Florida.

Aside from the effect that a cancellation on EBDC use may have on the price of squash, it is possible to determine the total losses that would be incurred in the state of Florida because of such a cancellation. Such an estimate would be a product of the increase in material cost per acre $46.93 and the acres affected by the cancellation, $12,100. The dollar losses would be approximately $568.0 thousand (Table II-25a).

Summary of Loss on Cucurbit Crops

The following table gives a listing of the losses on all of the cucurbit crops that would be imposed by an EBDC cancellation.

Watermelon	$2,335.5 Thousand
Fresh Market Cucumbers	862.2 "
Cucumbers for Pickling	790.3 "
Cantaloups	252.0 "
Squash	568.0 "
Total	$4,808.0 "

For the latter four crops, the losses incurred are in the form of required additional outlay for more expensive fungicides. The consequences of price changes were addressed for watermelon.

Impact on Net Returns

Production cost estimates are not available for most of the areas in which the cucurbit crops are grown. Consequently, no attempt will be made in this section to do a complete assessment of the decline in net revenue per acre that would be incurred by all growers in all areas from an EBDC cancellation. However, since yield reductions are not a factor in the impact of an EBDC ban, the need for production cost information is somewhat alleviated. The reduction in net return arises solely from increases in the material cost necessary for disease control.

In regard to the cucurbit crops, there are few, if any, cases in which the added material costs appear significant enough to force an important acreage shift.

An EBDC cancellation may, in some cases, have a major impact on net returns received by growers in a restricted local area. However, the significance of this impact for the entire U.S. market for this commodity would be small.

Watermelons

The example of watermelon production in Mississippi is an instance in which impact on net returns could be significant for growers but would not be significant for total U.S. production if crop changes were made on the affected acreage.

The added material cost imposed by a cancellation on the use of EBDC fungicides could induce a gradual shift to another crop in this State. Table II-14a shows that the added material cost would be 11.9 percent of total revenue per acre. However, no production budgets are available for watermelons in this State. Thus, an assessment of the impact of an EBDC ban on net returns is not possible. However, it can be seen from the tables on watermelons, that there would be a small impact on U.S. watermelon production from a major acreage shift in Mississippi. Table. II-13 shows that 29 percent of the Mississippi acreage is treated with the EBDC fungicides. This percentage would amount to 0.9 percent of total U.S. production being treated in the State of Mississippi. Thus, even if all of this acreage were to shift to alternative crops in this State, it would not have a significant impact on the supply of this commodity in the U.S.

The net returns on watermelon production in Florida warrants closer attention since a much larger percentage of U.S. watermelon output is accounted for by production in this State. Table II-13 shows that Florida acreage treated with EBDC fungicides accounts for 26.8 percent of U.S. protection. If growers were forced to use chlorothalonil (Bravo), the added cost per acre would be $38.19 (Table II-14a). This increase would be 7.7 percent of total revenue per acre as shown in Table II-14b.

Table II-15 shows a production budget for one area in Florida—the Immokdalee-Lee area. This budget covers production cost for a very small percentage of the total Florida watermelon acreage. For the 1976-77 period the acreage covered by the budget is 220 acres. Table II-13 shows that the average annual acreage for 1975-77 period was 59,000 acres in Florida. Thus, the prodcution budget covers the area in Florida that is less than one-half of one percent of the States total acreage. Since there are no other production budgets available for this crop in this State, it is a matter of conjecture concerning the extent to which the budget may be representative.

One of the differences between the area covered by the budget and the average for all of Florida can be found in yield per acre. The budget data shows that the yield per acre in the Immokalle-Lee area is 431 cwt per acre per season. However, the average yield per acre per season for the State, as a whole, is 152 cwt per acre per season. It is thus apparent that the average productivity per acre in the area covered by the budget differs significantly from the average for the entire State. Thus, the revenue per acre and cost per acre would not be representative of the State of Florida as a whole.

The increase of $38.19 in material cost per acre would reduce net return per acre in the Immokalee-Lee area from $356.81 to $318.62. This estimate is based on the assumption that the net return shown in Table II-15 for the 1976-77 period will also hold for later periods. Certainly an increase in material cost of this magnitude would have minimal effect on acreage allocation in the part of Florida covered by the budget.

Fresh Market Cucumbers

As noted above, Florida is also a major producer of fresh market cucumbers. 27/ The increase in cost per acre that would be imposed by an EBDC cancellation is $41.33 as indicated in Table II-17a. The table also shows that this increase in cost would be 3.5 percent of the annual total revenue per acre-- $1,184.00.

Tables II-18 and II-19 show total production costs for fresh market cucumbers. 28/ The two areas covered by these budgets are the Immokalee-Lee area and the Palm Beach-Broward area. The difference between total prodcution cost and total crop sales in the former area of Florida leaves a net return to the growers of $82.72 (Table II-18). The added cost that would be incurred for Chlorothalonil, the preferred alternative, would reduce this net return to $41.39. Such a reduction in net return could induce a shift in acreage to other crops but the extent of such a shift is estimated to be small. 9/

In the Palm Beach-Broward area, the net returns per ace in the 1976-77 period averaged $132.70, as shown in Table II-19. 29/

27/ The description of Florida's share of U.S. prodcution is found at the beginning of the section of cucurbit crops.

28/ These budgets do not include an imputation for management cost. The net revenue or net return are treated as returns to management.

29/ The budget shown in Table II-19 does not include an imputation for management cost.

The use of Bravo instead of EBDC would add $41.33 to the cost of production cost per acre. This increase in cost would reduce net returns per acre per season to $91.37. This level of net return per acre would be adequate to impede any shift to alternative crops in Florida. 9/

Cucumbers for Pickles

Production cost budgets are not available for the three States listed in Table II-20. Thus, no judgement can be made concerning the impact on net returns of an EBDC cancellation on this crop.

Cantaloups

Texas would be the one state affected by a ban on the use of EBDC fungicides on cantaloups. The change in cost that would be imposed by such a cancellation is $20.29 per acre (Table II-23a). This increase in material cost per acre is only 1.5 percent of total revenue generated per acre in Texas. It is doubtful that an increase of this magnitude would lower net returns to the point at which there were important acreage shifts out of cantaloup production into alternative crops.

Squash

The EBDC's are currently used on 100 percent of the squash acreage in Florida. It is expected the preferred alternative fungicide, Chlorothalonil would be used in all of the 12,100 acres currently treated with the EBDC fungicides if the latter material were cancelled. The added cost that would be incurred by growers would be $46.93 per acre. Tables II-26,

II-27 and II-28 show how such a cost increase would affect the level of net returns in squash producing areas in Florida. In the areas of Dade County, Immokalee-Lee, and Palm Beach-Broward, the net returns per acre are respectively, - $8.91, $329.57, and $18.25. Obviously, the cost increase could be easily absorbed by growers in the Immokalee-Lee area of Florida; the increase in cost for the alternative fungicides would reduce net return per acre to $292.64. This level of net return would still be very high compared with other vegetable crops grown in the State of Florida.

In Dade County, growers incurred a loss per acre of $8.91. An increase in cost of $46.93 would increase this loss per acre to $55.84 if the reason for this loss per acre were to persist. However, Table II-26 shows that losses were incurred in the 1976-77 period because the yield had fallen from the 5-season average. If yields had been maintained, the net return would have exceeded $100 per acre. This net return per acre would permit the Dade County squash growers to absorb the increased cost for fungicide without being forced into alternative crops. It is a reasonable expectation that yield levels for squash in the Dade County area will return to a level equal to the 5-season average. Thus, no acreage shift would be expected in this area.

In the Palm Beach-Broward area, a similar situation arises. The additional cost that would be incurred for the alternative fungicide, chlorothalonil, would reduce the net return per acre from $18.25 to -$28.68. However, Table II-28 shows that the yield per acre for the 1976-77 period was 26 bushels below the 5 season average. If yield had been maintained at the 5-season average and if growers were to have received the price

of $7.85 (shown in Table II-28), the total crop sales would have been more than $200 greater than the value shown in the table. With this level of gross returns per acre, the growers in the Palm Beach-Broward area could much more easily absorb the added cost that would be incurred for chlorothalonil. It is assumed that future yield levels will return to a level equal to or greater than that of the 5 season average. Thus, no acreage shift to any alternative crops would be anticipated in this area in Florida.

Consumer Impact

Changes in the Quantity and Quality of the Product Available

The preferred alternative fungicide, chlorothalonil, would be equally effective in the control of diseases affecting cucurbits. Thus, there would be no reduction in the quality of the vegetables in this group of commodities.

The use of the preferred alternative fungicide would result in no yield reductions for any of the cucurbit crops affected. Thus, there would be no reduction in the quantity of any on the cucurbit vegetables available to the consumer. In the case of watermelons, there would be an estimated 0.4 percent reduction in the quantity produced, however this adjustment would occur because of the upward shift in equilibrium price. This increase in price will be mentioned below in regard to changes in total expenditure by consumers.

Changes in Consumer Expenditure

The increases in price of the cucurbit vegetables that would occur because of an EBDC cancellation are estimated to be small at the farm level.

The increase in price was estimated to be less than one percent for all of these commodities with the exception of watermelons. It is assumed that for all of the curcubit commodities except watermelons, the increase in price at the retail level will be small enough to ignore. This "rule of thumb" is in accord with procedure specified in the Introduction to the vegetable section. Thus, it is also assumed that there would be no "significant" additional outlay on the part of consumers for cucumbers, cantaloup or squash as a result of price increases induced by an EBDC cancellation.

Since the increase in price for watermelons is expected to exceed 1.0 percent at the farm level, an estimate will be made of the extent of the increase in price at the retail level. This "rule of thumb" is in accord with procedure specified in the Introduction to the vegetable section.

The estimate of increase in price at the retail level must take account of the marketing margin between the retail price and farm level price. The assumption is made that this margin remains relatively stable through time. The estimated marketing margin for watermelon is 31.3 percent. 30/ This percentage means that the farm level price is 68.7 percent of the retail price. The average annual farm level price for the period 1975-1977 was $3.54 per cwt. If the marketing margin for this period was 31.3, the implied retail price is $5.15 per cwt.

The determination of response of retail level price change in price at the farm level requires some knowledge of the elasticity of

30/ This percentage is an average for 9 fresh market vegetables which does not include watermelons. The vegetables included carrots, celery, cucumbers, lettuce, onions, potatoes (round white), potatoes (russet), spinach, sweet potatoes. The estimated percentage is based on prices for January 1978 as reported in the publication Vegetable Situation, Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture, May 1978.

price transmission. 31/ Unfortunately, no such elasticity is available for watermelons. Of the elasticities that have been calculated for fresh market vegetables, that of fresh market tomatoes is highest with a value of 0.92 (11). This elasticity indicates that a one percent increase in price at the farm level will induce a 0.92 percent increase in price at the retail level. If this elasticity is used as a proxy in estimating the change in retail level price for watermelons, one would derive an estimate that could be considered a maximum. Thus, a 1.26 percent increase in price at the farm level would be followed by a maximum 1.16 percent increase in price at the retail level. 32/ This increase would shift the retail level price upward from $5.15 per cwt. to $5.21 per cwt (hundred weight).

The average annual quantity of watermelons marketed over the 1975-77 period was 25,395 thousand cwt. The estimated quantity that would be marketed after the increase in price would be 25,293 thousand cwt. This reduction would be 0.4 percent. 33/ It is assumed that these quantities would apply at the retail. Thus, estimated consumer expenditures would

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31/ This elasticity is a ratio of percentage change in price at the retail level in response to a one percent change in price at the farm level.

32/ This estimated percentage would be obtained by multiplying the elasticity of price transmission by the percentage change in price at the farm level.

33/ These estimates were described in the section above on estimated increase in price for watermelons.

increase from the average annual value of $130.8 million to a maximum of $131.8 million. In other words, the estimated maximum additional outlay that would be made consumers is approximately $1.0 million. This estimate would reflect the impact at the consumer level of a cancellation on the use of EBDC fungicides on curcubit vegetables.

Table II-13 Acreage and production affected - Watermelons

State	Ave. acres planted 1975 -1977 1/	Percent acres treated - EBDC 1976 2/	Expected annual acres treated with EBDC	Ave. annual production 1975 - 1977 (1,000 cwt)	Percent of average U.S. production 4/	Percent of average U.S. production treated in the state 5/
Florida	59,000	76	44,840	8,964	35.3	26.8
Texas	57,333	55	31,533	5,151	20.3	11.2
Georgia	34,567	66	22,814	2,412	9.5	6.3
South Carolina	22,000	80	17,600	1,331	5.2	4.2
Alabama	14,567	13	1,894	1,041	4.1	0.5
Mississippi	12,800	29	3,712	753	3.0	0.9

1/ Vegetables 1977 Annual Summary Crop Reporting Board, USDA.

2/ Assessment of EBDC Fungicide Use In Agriculture, Part II USDA/State/EPA Assessment Team April, 1978.

3/ Vegetables 1977 Annual Summary.

4/ Ibid.

5/ The percentages are derived from the information given columns 2 and 5.

Table II-14a. Treatment cost per acre and total - watermelon

State	Ave. number of EBDC applications per acre 1/	Lbs. active ingredient applied per acre per application 2/	Estimated EBDC A.I. applied per acre per season	Estimated materials cost per acre with EBDC fungicides 3/	Estimated quantity of preferred alternative used per acre per season (units A.I.) 4/	Estimated materials cost per acre with the perferred alternative 5/	Difference in material cost per acre with alternative	Total cost impact for the state (1,000 dol.) 6/
Florida	6.5	1.6	10.4	19.76	12.2	57.95	38.19	1,484.8
Texas	3.0	2.0	6.0	11.40	4.5	21.38	9.98	143.1
Georgia	6.0	1.6	9.6	18.24	9.0	42.75	24.51	397.8
South Carolina	5.0	1.5	7.0	13.30	7.5	35.63	22.33	308.7
Alabama	7.0	2.0	14.0	26.60	10.5	49.88	23.28	11.7
Mississippi	5.0	2.0	10.0	19.00	7.5	35.63	16.63	46.3

1/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978. The specific EBDC fungicide used is maneb.

2/ Ibid.

3/ The estimated average annual price of the EBDC fungicide is $1.90 per lb. a.i. This price for EBDC is an average derived from several price lists.

4/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978. The alternative would be Chlorothalonil.

5/ The estimated price for Chlorothalonil is $4.75 per lb. a.i. This price is an average derived from several price lists.

6/ The estimates are the arithmetic product of the acres treated (Table II-13) and the difference in fungicide cost per acre with the alternative.

Table II- 14b Impacts on Production Cost- Watermelon

State	Proportion of U.S. production treated in the States 1/	Ave. Revenue per acre 1975-77 (est. ave. Cost) 2/	Increase in material cost with alt. fungicide 3/	Est percent change in cost per acre	Est weighted percent impact on U.S. ave. production cost 4/
Florida	0.268	494	38.19	7.7	2.06
Texas	0.112	380	9.98	2.6	0.29
Georgia	0.063	568	24.51	4.3	0.27
South Carolina	0.042	424	22.33	5.3	0.22
Alabama	0.005	259	23.28	9.0	0.05
Mississippi	0.009	140	16.63	11.9	0.11
Totals	0.499				3.00

1/ Source: Vegetable 1977 Annual Summary Crop Reporting Board, USDA. The proportions are obtained by dividing the percentages in the right most column of Table II-13 by 100. The total 0.499 represents the proportion of U.S. production treated.

2/ Source: Ibrid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the appendix.

3/ Source: See Table II-8a.

4/ Each item in the column represents the percentage impact on U.S. production cost originating in the state. The column total, 3.00, represents the weighted percent change in average U.S. production cost of the commodity that would result from an EBDC cancellation.

Table II-15. Watermelons: Costs and returns in the Immokalee-Lee area 5-season average 1972-76 and 1976-77

Item	5-season average	1976-77
Number of growers	6	4
Number of acres	702	220
Average acres per grower	117	55
Average yield per acre (cwt.)	215	431

Growing costs:	Acre	Average per Acre	Average per Cwt.
Land rent	$ 20.31	$ 23.08	
Seed	8.06	3.78	
Fertilizer	159.70	179.00	
Spray and dust	92.69	97.62	
Cultural labor	136.31	110.92	
Machine hire	50.26	63.79	
Gas, oil and grease	24.63	29.52	
Repair and maintenance	41.72	35.32	
Depreciation	28.23	31.25	
Licenses and insurance	14.73	20.16	
Interest on production capital (9% - 5 months)	21.30	21.67	
Interest on capital invested (other than land)	4.24	4.69	
Miscellaneous expense	19.07	9.81	
Total growing cost	621.75	635.61	$ 1.475
Harvesting and marketing costs:			
Picking expense	66.19	129.38	.300
Packing expense	56.15	107.81	.250
Containers	22.32	21.56	.050
Hauling	87.10	178.25	.414
Selling	52.70	79.06	.183
Total harvesting and marketing cost	284.46	516.06	1.197
Total crop cost	906.21	1151.67	2.672
Crop sales	1010.21	1503.43	3.500
Net return	$104.00	$356.31	$ .328

	1976-77 range per acre From	1976-77 range per acre To
Yield (cwt.)	340	575
Total growing cost	$ 531.74	$ 330.47
Total harvesting and marketing cost	391.00	713.75
Total crop cost	1018.01	1271.93
Crop sales	1020.00	2300.00
Net return	$ -132.97	$ 1216.26

Source: D. L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 with Comparisons, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, March 1978.

Table II-16 Acreage and Production Affected - Fresh Cucumbers

State	Average acres planted 1975 1977 1/	Percent acres treated-EBDC 1976 2/	Expected annual acres treated with EBDC	Average production 1975 - 1977 (1000 CWT) 3/	Percent of average U.S. production 1975-77 4/	Percent of U.S. production treated in the state
Florida	15,867	83	13,170	1,976	38.4	31.9
N. Carolina	8,633	20	1,727	416	8.1	1.6
S. Carolina	5,766	100	5,766	400	7.8	7.8
Michigan	2,067	60	1,240	153	3.0	1.8

1/ Vegetable 1977 Annual Summary, Crop Reporting Board, USDA.

2/ Assessment of EBDC Fungicide Uses In Agriculture Part II, April, 1978

3/ Vegetables 1977, cited above

4/ Ibid.

Table II-17a. Treatment cost per acre and total - fresh market cucumbers

State	Average number of EBDC applications per acre 1/	Pounds active ingredient applied per acre per application 2/	Estimated EBDC A.I. applied per acre per season	Estimated materials cost per acre with EBDC fungicides 3/	Estimated quality of preferred alternative used per acre per season (units A.I.) 4/	Estimated materials cost per acre with the preferred alternative 5/	Difference in material cost per acre with alternative	Total cost impact for the State (1,000 dol.) 6/
Florida	6.8	1.4	9.5	18.05	12.5	59.38	41.33	544.3
N. Carolina	5.0	1.4	7.0	13.30	9.4	44.65	31.35	54.1
S. Carolina	4.5	1.4	6.3	11.97	8.4	39.90	27.93	161.0
Michigan	6.0	1.4	8.4	15.96	11.3	53.68	37.72	46.8
Total								806.2

1/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978. The specific EBDC fungicide used is maneb.

2/ Ibid.

3/ The estimated average price of the EBDC fungicides is approximately $1.90 per lb. a.i. This estimated price for EBDC is an average compiled from several current price lists.

4/ Chlorothalonil is the preferred alternative. Application rate is formed in Assessment of EBDC Fungicide Uses in Agriculture - Part II

5/ The estimated average price for Chlorothalonil is approximately $4.75 per lb. a.i. The cost is an estimate derived from an average of several price lists.

6/ These estimates are the arithmetic products of the acres treated (Table II-16) and the difference in material cost per acre with the alternative.

Table II 17b Impacts on Production Cost- Fresh Market Cucumbers

State	Proportion of U.S. production treated in the States 1/	Ave. Revenue per acre 1975-77 (est. ave. cost) 2/	Increase in material cost with alt. fungicide 3/	Est. percent change in cost per acre	Est weighted percent impact on U.S. ave. production cost 4/
Florida	0.319	1184	41.33	3.5	1.12
North Carolina	0.016	418	31.35	7.5	0.12
South Carolina	0.078	735	27.93	3.8	0.29
Michigan	0.018	717	37.72	5.3	0.10
Total	0.431				1.63

1/ Source: Vegetable 1977 Annual Summary Crop Reporting Board, USDA. The proportions are obtained by dividing the percentages in the right most column of Table II-16 by 100. The total 0.431 represents the proportion of U.S. production treated.

2/ Source: Ibid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the appendix.

3/ Source: See Table II-8a.

4/ Each item in the column representes the percentage impact on U.S. production cost originating in the state. The column total, 1.63, represents the weighted percenta change in average U.S. production cost of the commodity that would result from an EBDC cancellation.

Table II-18. Cucumbers: Costs and returns in the Immokalee-Lee area season 1976-77

Item	1976-77	
Number of growers	6	
Number of acres	790	
Average acres per grower	132	
Average yield per acre (bushels)	262	
Growing costs:	Average per	
	Acre	Bushel
Land rent	$ 27.25	
Seed	17.52	
Fertilizer	173.51	
Spray and dust	78.33	
Cultural labor	202.62	
Machine hire	26.64	
Gas, oil and grease	51.32	
Repair and maintenance	48.94	
Depreciation	42.67	
Licenses and insurance	24.81	
Interest on production capital (9% - 4 months)	24.85	
Interest on capital invested (other than land)	6.40	
Miscellaneous expense	13.58	
Total growing cost	736.44	$ 2.311
Harvesting and marketing costs:		
Picking expense	280.29	1.070
Grading and packing expense	213.12	.813
Containers	139.88	.534
Hauling	48.52	.135
Selling	43.26	.165
Total harvesting and marketing cost	725.07	2.767
Total crop cost	1461.51	5.573
Crop sales	1544.23	5.394
Net return	$ 82.72	$ .316

	1976-77 range per acre	
	From	To
Yield (bushels)	201	325
Total growing cost	$ 618.13	$ 1098.50
Total harvesting and marketing cost	562.50	856.50
Total crop cost	1269.44	1904.90
Crop sales	1220.73	1833.30
Net return	$-101.37	$ 308.12

Source: D. L. Brooke, Costs and Returns from [illegible] Crops in Florida, Season 1976-77 with Comparisons, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, March 1978.

Table II-19. Cucumbers: Costs and returns in the Palm Beach-Broward area season 1976-77

Item	1976-77
Number of growers	3
Number of acres	290
Average acres per grower	97
Average yield per acre (bushels)	198
Growing costs:	Average per Acre
Land rent	$ 71.02
Seed	39.58
Fertilizer	78.33
Spray and dust	74.95
Cultural labor	231.90
Machine hire	16.08
Gas, oil and grease	38.68
Repair and maintenance	46.25
Depreciation	30.34
Licenses and insurance	33.89
Interest on production capital (9% - 4 months)	19.86
Interest on capital invested (other than land)	4.55
Miscellaneous expense	31.20
Total growing cost	716.63
Harvesting and marketing costs:	
Picking expense	181.99
Grading and packing expense	106.34
Containers	112.13
Hauling	29.54
Selling	32.81
Total harvesting and marketing cost	462.81
Total crop cost	1179.44
Crop sales	1312.14
Net return	$ 132.70

	1976-77 range per acre From	1976-77 range per acre To
Yield (bushels)	150	233
Total growing cost	$ 586.21	$ 801.09
Total harvesting and marketing cost	352.50	523.58
Total crop cost	938.71	1313.43
Crop sales	930.00	1542.77
Net return	$ -8.71	$ 229.34

Source: D. L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 with Comparisons, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, March 1978.

Table II-20. Acreage and Production Affected - Cucumbers for Pickles

State	Average acres planted 1975 1977 1/	Percent acres treated-EBDC 1976 2/	Expected annual acres treated with EBDC	Average production 1975-1977 3/ (Tons)	Percent of average U.S. production 1975-1977 4/	Percent of U.S. production treated in the State
Michigan	27,533	59	16,244	115,500	17.9	10.6
N. Carolina	28,900	30	8,670	76,933	11.9	3.6
S. Carolina	9,167	100	9,167	23,817	3.7	3.7

1/ Vegetables 1977 Annual Summary Crop Reporting Board, USDA

2/ Assessment of EBDC Fungicide Uses in Agriculture Part II, USDA/State/EPA Assessment Team, April 1978.

3/ Vegetables 1977 Annual Summary

4/ Ibid.

Table II-21a. Treatment cost per acre and total - cucumbers for pickles

State	Average number of EBDC applications per acre 1/	Pounds active ingredient applied per acre per application 2/	Estimated EBDC A.I. applied per acre per season	Estimated materials cost per acre with EBDC 3/	Estimated quantity of preferred alternative used per acre per season (units A.I.) 4/	Estimated materials cost per acre with the preferred alternative 5/	Difference in material cost per acre with alternative	Total cost impact for the State (1,000 dol.) 6/
Michigan	4.5	1.2	5.4	10.26	6.75	32.06	21.80	354.1
N. Carolina	6.0	1.2	1.2	13.68	9.0	42.75	29.07	252.0
S. Carolina	4.5	1.2	1.4	11.97	6.75	32.06	20.09	184.2
Total								790.3

1/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978. The specific EBDC fungicide used is maneb.

2/ Ibid.

3/ The estimated average price of the EBDC fungicides is approximately $1.90 per lb. a.i. This price of EBDC is an average derived from annual price lists.

4/ Chlorothalonil is the alternative; Source: Assessment of EBDC Fungicide Uses in Agriculture, Part II.

5/ The price of Chlorothalonil is estimated to be about 4.75 per lb. a.i. This is an average derived from annual price lists.

6/ These estimates are the arithmetic products of the acres treated (Table II-20) and the difference in material cost per acre with the alternatives.

Table II 21b. Impacts on Production Cost- Cucumbers for Pickles

State	Proportion of U.S. production treated in the States 1/	Ave. Revenue per acre 1975-77 (est. ave. cost) 2/	Increase in material cost with alt. fungicide 3/	Est. percent change in cost per acre	Est weighted percent impact on U.S. ave. production cost 4/
Michigan	0.106	$ 484	$ 21.80	4.5	0.48
North Carolina	0.036	358	29.07	8.1	0.29
South Carolina	0.037	338	20.09	5.9	0.22
Total	0.179				0.99

1/ Source: Vegetable 1977 Annual Summary Crop Reporting Board, USDA. The proportions are obtained by dividing the percentages in the right most column of Table II-20 by 100. The total 0.179 represents the proportion of U.S. production treated.

2/ Source: Ibid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the appendix.

3/ Source: See Table II -21 a.

4/ Each item in the column represents the percentage impact on U.S. production cost originating in the state. The column total, 0.99, represents the weighted percent change in average U.S. production cost of the commodity that would result from an EBDC cancellation.

Table II-22. Acreage and production affected - Cantaloups

States	Average acres planted 1975 - 1977 1/	Percent acres treated - EBDC 1976 2/	Expected annual acres treated with EBDC	Average annual production 1975 - 1987 (1,000 cwt) 3/	Percent of average annual U.S. production 4/	Percent of average U.S. production treated in the state 5/
Texas	16,567	75	12,425	1,658	16.3	12.2

1/ <u>Vegetables 1977 Annual Summary</u> Crop Reporting Board, U.S.D.A.

2/ <u>Assessment of EBDC Fungicide Uses In Agriculture</u> Part II, USDA/STATE/EPA Assessment Team, April, 1978.

3/ Ibid.

4/ Ibid.

5/ These percentages are derived from the information given in columns 2 and 5 in this table.

Table II-23a. Treatment cost per acre and total - cantaloups

State	Ave. number of EDBC applications per acre 1/	Lbs., active ingredient applied per acre per application 2/	Estimated EBDC A.I. applied per acre per season	Estimated materials cost per acre with EBDE fungicides 3/	Estimated quantity of preferred alternative used per acre per season (units A.I.) 4/		Estimated average material cost per acre with each alternative applied to fifty percent of currently treated acres 5/	Average difference in material cost per acre with alternatives	Total cost impact for the State (1,000 dol.) 6/
					Bravo:	Difolatan			
Texas	4.5	2.0	9.0	17.10	10.1	9	37.37	20.27	252.0

1/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April, 1978. The specific EBDC fungicide used in maneb.

2/ Ibid.

3/ The estimated price of the EBDC fungicides is approximately $1.90 per lb. a.i. This price of EBDC is an average derived from several current price lists.

4/ The Assessment of EBDC - Part II.

5/ The percentages were obtained through personal communication with Dr. Albert Paulus, Plant Pathologist, University of California, Riverside, member of the EBDC Assessment Team. The estimated average price of Chlorothalmil is $4.75 per lb. a.i. and the estimated average price of Difolatan is $2.75 per lb. a.i. Both prices are averages developed from current price lists.

6/ These estimates are the arithmetic products of the acres treated (Table II-22) and the difference in material cost per acre with the alternative.

Table II-23b. Impacts on Production Cost - Cataloups

State	Proportion of U.S. production treated in the States 1/	Ave. Revenue per acre 1975-77 (est. ave. cost) 2/	Increase in material cost with alt. fungicide 3/	Est. percent change in cost per acre	Est weighted percent impact on U.S. ave. production cost 4/
Texas	0.122	$1351	20.27	1.5	0.18

1/ Source: Vegetable 1977 Annual Summary Crop Reporting Board, USDA. The proportion is obtained by dividing the percentage in the right most column of Table II-22 by 100.

2/ Source: Ibid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the appendix.

3/ Source: See Table II-23a.

4/ The number 0.18 represents the percentage impact on U.S. production coat originating in the state.

Table II-24. Acreage and production affected - Squash.

States	Ave. acres planted 1975 - 1977 1/	Percent acres treated - EBDC 1976 2/	Expected annual acres treated with EBDC	Production in the State
				1000 bushels
Florida	12,100	100.0	12,100	1,815 3/

1/ Estimate obtained from the Crop Reporting Board Field office in Orlando, Florida

2/ Source: EBDC Fungicide Use in Agriculture, USDA/STATE/EPA Assessment Team; Part II, an Analysis of Current Impacts to Agriculture from Changes in EBDC Use Patterns.

3/ Source: Florida Agricultural Statistics, Vegetable Summary 1977, Florida Crop and Livestock Reporting Service.

Table II-25a. Treatment cost per acre and total - squash

State	Ave. number of EBDC applications per acre 1/	Lbs. active ingredient applied per acre per application 2/	Estimated EBDC a.i. applied per acre per season 3/	Estimated materials cost per acre with EBDE fungicides 4/	Estimated quantity of preferred alternative used per acre per season (units a.i.) 5/	Estimated materials cost per acre with the preferred alternative 6/	Difference in material cost per acre with alternative	Total cost impact for the State (1,000 dol.) 7/
Florida	8	1.6	12.8	24.32	15.0	71.25	46.93	568.0

1/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April, 1978. The specific EBDC fungicide used is maneb.

2/ Ibid.

3/ Ibid.

4/ The estimated average price of the EBDC fungicides is $1.90 per lb. a.i. This price of EBDC is an average derived from several price lists.

5/ Bravo or Chlorothalonil is the alternative that would be used; Source: Assessment of EBDC Use - Part II.

6/ The estimated price for Bravo is $4.75 per lb. a.i. This estimate is an average derived from several current price lists.

7/ These estimates are the arithmetic products of the acres treated (Table II-24) and the difference in material cost per acre with the alternative.

Table II-25b. Impacts on production cost - Squash

State	Average revenue per acre 1975-77 (est. average cost) 1/	Increase in material cost with alternative fungicide 2/	Estimated percent change in cost per acre
Florida	$927	46.93	5.1

1/ Source: Table II-25a. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the Appendix.

2/ Source: Ibid.

Table II-26. Squash: Costs and returns in the Dade County area 5-season average 1972-76 and 1976-77

Item	5-season average	1976-77	
Number of growers	6	7	
Number of acres	1236	1250	
Average acres per grower	206	179	
Average yield per acre (bushels)	144	124	
Growing costs:			
		Average per	
	Acre	Acre	Bushel
Land rent	$ 36.21	$ 37.64	
Seed	14.02	18.75	
Fertilizer	67.83	68.02	
Spray and dust	63.37	66.11	
Cultural labor	58.97	65.74	
Machine hire	12.31	13.57	
Gas, oil and grease	23.32	28.30	
Repair and maintenance	33.16	32.75	
Depreciation	21.75	21.37	
Licenses and insurance	27.42	36.14	
Interest on production capital (9% - 4 months)	10.39	11.47	
Interest on capital invested (other than land)	3.28	3.28	
Miscellaneous expense	9.37	15.50	
Total growing cost	381.88	419.14	$ 3.360
Harvesting and marketing costs:			
Picking and packing expense	193.06	134.43	1.487
Containers	111.14	89.32	.722
Hauling	20.06	18.63	.151
Selling	31.83	32.89	.265
Total harvesting and marketing cost	356.09	325.49	2.625
Total crop cost	737.97	744.63	6.005
Crop sales	839.43	735.72	5.933
Net return	$101.46	$ -8.91	$ -.072

	1976-77 range per acre	
	From	To
Yield (bushels)	85	168
Total growing cost	$ 311.35	$ 624.64
Total harvesting and marketing cost	215.05	464.56
Total crop cost	631.21	953.75
Crop sales	442.00	992.34
Net return	$ -276.28	$ 252.33

Source: D. L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 with Comparisons, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, March 1978.

Table II-27. Squash: Costs and returns in the Immokalee-Lee area 5-season average 1972-76 and 1976-77

Item	5-season average	1976-77	
Number of growers	5	6	
Number of acres	945	1336	
Average acres per grower	189	226	
Average yield per acre (bushels)	187	214	
Growing costs:		Average per	
	Acre	Acre	Bushel
Land rent			
Seed	$ 23.21	$ 31.55	
Fertilizer	18.34	23.25	
Spray and dust	111.22	132.40	
Cultural labor	43.27	61.05	
Machine hire	68.48	111.57	
Gas, oil and grease	13.22	17.40	
Repair and maintenance	27.10	36.31	
Depreciation	24.69	41.42	
Licenses and insurance	23.38	31.86	
Interest on production capital (9% - 4 months)	10.66	15.11	
Interest on capital invested (other than land)	3.54	4.78	
Miscellaneous expense	8.83	18.59	
Total growing cost	393.21	555.34	$ 2.595
Harvesting and marketing costs:			
Picking expense	113.10	134.34	.628
Grading and packing expense	118.31	154.62	.723
Containers	125.42	129.43	.605
Hauling	51.01	51.45	.240
Selling	41.15	44.33	.207
Total harvesting and marketing costs	448.99	514.17	2.403
Total crop cost	842.20	1069.51	4.998
Crop sales	987.34	1399.08	6.538
Net return	$145.64	$329.57	$ 1.540

	1976-77 range per acre	
	From	To
Yield (bushels)	159	300
Total growing cost	$ 361.04	$ 692.14
Total harvesting and marketing cost	344.75	909.00
Total crop cost	705.79	1368.62
Crop sales	1027.25	2250.00
Net return	$ -5.94	$ 831.38

Source: D. L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 with Comparisons, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, March 1978.

Table II-28. Squash: Costs and returns in the Palm Beach-Broward area 5-season average 1972-76 and 1976-77

Item	5-season average	1976-77	
Number of growers	5	4	
Number of acres	230	169	
Average acres per grower	46	42	
Average yield per acre (bushels)	124	98	
Growing costs:		Average per	
	Acre	Acre	Bushel
Land rent	$ 41.37	$ 53.09	
Seed	13.19	19.69	
Fertilizer	72.39	62.75	
Spray and dust	46.88	47.50	
Cultural labor	68.88	91.92	
Machine hire	27.47	17.06	
Gas, oil and grease	25.59	27.47	
Repair and maintenance	29.77	36.88	
Depreciation	23.63	29.59	
Licenses and insurance	21.12	20.38	
Interest on production capital (9% - 4 months)	10.94	11.51	
Interest on capital invested (other than land)	3.54	4.09	
Miscellaneous expense	17.88	7.05	
Total growing cost	402.65	428.98	$ 4.377
Harvesting and marketing costs:			
Picking and packing expense	151.64	169.64	1.731
Containers	97.76	109.49	1.117
Hauling	19.97	17.19	.176
Selling	25.13	25.95	.265
Total harvesting and marketing cost	294.50	322.27	3.289
Total crop cost	697.15	751.25	7.666
Crop sales	732.13	769.50	7.852
Net return	$ 34.98	$ 18.25	$ .186

	1976-77 range per acre	
	From	To
Yield (bushels)	60	130
Total growing cost	$ 322.50	$ 488.05
Total harvesting and marketing cost	222.00	403.00
Total crop cost	588.50	883.00
Crop sales	480.00	1083.00
Net return	$ -230.05	$ 200.00

Source: D. L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 with Comparisons, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, March 1978.

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING
EBDC USE ON ONIONS

A. USE: EBDC use on commercial onion production in Texas, New York, Michigan, and California.

B. MAJOR DISEASES CONTROLLED: Downey Mildew, Purple Blotch, and Botrytis Leaf Blight.

C. ALTERNATIVES:

<u>Major registered chemicals:</u> Dyrene and Chlorothalonil

State recommendations:

Number of States Recommending for Diseases

	Downey Mildew	Purple Blotch	Botrytis
EBDC	29	29	23
Dyrene	12	18	17
Chlorothalonil	3	7	12
No alternative to EBDC recommended	9	9	4

<u>Non-chemical controls:</u> Non-chemical control methods are not currently available

<u>Efficacy of alternatives:</u> Dyrene and Chlorothalonil provide equipment disease control as compared to EBDC.

<u>Comparative performance:</u> Yields and quality would remain the same if alternatives to EBDC are applied.

<u>Comparative costs:</u>

Season Chemical Cost Per Acre

State	EBDC	Alternative	Difference
Texas	$13.30	$21.38 1/	$ 8.08
New York	27.36	47.98 1/	20.62
Michigan	18.24	42.75 1/	24.51
California	15.96	24.94 1/	8.98

1/ Chlorothalonil
2/ Dyrene

<u>Conclusion:</u> Disease control, yields, and quality for onions can be maintained with registered and recommended alternative chemicals.

D. EXTENT OF USE:

<u>Active ingredient basis:</u> Current usage is estimated to be 840.000 pounds active ingredient on 52,600 areas in Texas, New York, Michigan, and California. Approximately 25% of total U.S. production is treated in those 4 states.

E. ECONOMIC IMPACTS:

<u>User:</u> Users face average production cost increases of 0.4% in Texas, 0.9% in New York, 1.1% in Michigan, and 0.3% in California. Total annual increases are $180,049(TX), $218,237(NY), $97,233(MI), and $20,240(CA). These cost increases should not induce significant shifts in cropping patterns.

<u>Market:</u> No market shifts are expected.

<u>Consumer:</u> Quantity, quality and price should not change significantly if alternative chemicals are used.

<u>Macroeconomic:</u> None expected.

F. SOCIAL/COMMUNITY IMPACTS: Not investigated since economic impacts are minimal.

G. LIMITATIONS OF ANALYSIS: Usage data was provided by EBDC Assessment Team members based on personal knowledge, contacts with colleagues, and some published information. Since formal survey data were not available, these team members provided the best currently available data in this area.

H. PRINCIPAL ANALYST AND DATE:

John Bratland, USDA
Gary Ballard, EPA
September 1, 1978

Onions

User Impact

The cancellation of EBDC use on onions would have impacts in the following listed farm States in declining order of total production: Texas, New York, Michigan, and California (see Table II-29). No decline in production levels would be expected in any of these States nor would there be any significant increase in cost of production as a result of using alternative materials for fungus control (15,21).

Onions are affected by three primary diseases that necessitate the use of fungicides in each of the four mentioned States (1). These diseases are downy mildew, purple blotch and botrytis leaf blight. The EBDC fungicides are effective in the control of all three diseases.

Alternative Control Programs

Anilazine and chlorothalonil would be the two alternatives used in the impacted four States. In each case, these alternatives would have the same number of applications as the EBDC fungicides. Also, the alternatives would be used on the same acreage that are currently treated with the EBDC fungicides.

In the State of Texas, EBDC fungicides are applied on an average of 3.5 times during the season in a total quantity of 7.0 lbs. active ingredient per acre. In the event of a cancellation of EBDC use on onions, chlorothalonil would be applied on an average of 3.5 times in a total quantity of 4.0 lbs. (a.i.).

In New York, 6 applications of the EBDC fungicide is applied during the growing season. The total quantity of the EBDC's applied would be 14.4 lbs. (a.i.). If the EBDC's applied would be 14.4 lbs.

(a.i.). If the EBDC's were cancelled, chlorothalonil would have the same number of applications. The total amount of chlorothalonil that would be used during the growing season would be approximately 10.1 lbs. (a.i.) of chlorothalonil per acre.

In Michigan there would be 9.0 lbs. chlorothalonil applied per acre during the growing season. This quantity of chlorothalonil (measured in lbs. (a.i.)) would replace 9.6 lbs. of the EBDC fungicide applied in 8 applications per acre.

Onion growers in California would apparently use anilazine for control of purple blotch. The EBDC fungicides are currently applied in 3.5 applications (average) in a total quantity of 8.4 lbs. (a.i.) per acre. Anilazine would have in the same number of applications, but a total quantity per season of 5.25 lbs. (a.i.) per acre.

Impact on Production Costs

The use of the alternative fungicides would impose additional costs on the onion growers in each of these States. The main reasons for the additional costs is related to the higher costs per pound of active ingredient and given the rates used, the cost per treatment is therefore higher. The EBDC fungicides sell for an average price of $1.90 per pound of (a.i.). However, chlorothalonil has an average price of $4.75 per lb. (a.i.) and anilazine costs $5.70 per lb.(a.i.).

The same theory, rationale and assumptions as were used in the analysis of fresh market tomato prices will be employed here to estimate percentage change in production cost (see the Appendix to the vegetable section). Thus the dollar values in the second column of Table II-30b

would be interpreted as estimates of long-run average cost per acre in the four affected States. These estimates are $1,994 for California, $2,374 for Michigan, $2,287 for New York and $2,573 for Texas. The added material cost of $24.51 in material cost in Michigan would thus represent an estimated 1.1 percent increase in production cost. In New York the additional material cost per acre of $20.62 would amount to a 0.9 percent increase in production cost per acre. In both of the other States, the added material cost would be less than one-half of one percent of the estimated average cost per acre.

Changes in Yield, Quality, Production

The conversion to alternative fungicides in the four affected States is expected to have no impact on yield or quality of onions harvested. No significant adjustments in production units would be expected.

Changes in Commodity Prices and Farm Income

The impact of a cost increase on the price of onions will depend on the magnitude of the cost increase and upon the elasticities of supply and demand. The demand elasticity has been estimated to be -0.12 at the farm level. (11) The elasticity of supply is estimated to be 0.34. (14)

The cost information required to estimate the percentage change in price is the weighted percentage increase in production cost for the U.S. as a whole. The weighted sum in the rightmost column, 0.17, is the percentage that will be used in estimating the price change. The estimate

of percentage change in price that would result from this cost increase is 0.13. 34/ Thus, the price impact of an EBDC cancellation on onions would be relatively insignificant.

It will be assumed that the price of onions at the farm level in each of the respective States will not change significantly. Thus, there will be no measureable income distribution effect such as would be the case if onion prices were to increase because of the cancellation. The impact of cancellation would be limited to the net revenue loss on the acres affected. The impact in New York would be the greatest with an estimated $218.2 thousand added outlay made by growers. The added total material costs in Texas would be $180 thousand (Table II-30a). The total dollar impact (added costs) in the four affected States is $515.8 thousand (Table II-30a).

Impact on Returns to Farmer's Land, Labor and Management

Since there would be no significant price increases for onions resulting from an EBDC cancellation the "estimated increase in cost per acre with alternative" shown in Table II-30a would reflect the reduction in net return per acre on the affected acreage. It is not expected that these increases in cost per acre will induce shifts to alternative crops. (23)

34/ The estimate is obtained through the use of the following formula:

$$\%\text{ change in price} = \frac{(\%\text{ change in cost})\ (\text{supply elasticity})}{\text{supply elasticity} + \text{demand elasticity}} = 0.13$$

% change in cost = 0.17 percent
Supply elasticity = 0.34
Demand elasticity = 0.12 (absolute value)

See the Appendix for further information on the appropriate use of the formula and the assumptions inherent in its use.

Consumer Impact

Changes in Quantity and Quality of Product Available

There would be no reduction in grade or quality of onions as a result of a cancellation of EBDC use on onions. Also, there would be no important changes in the price of quantity of onions marketed.

Change in Consumer Expenditures

There would be no expected change in consumer expenditure on onions as a result of an EBDC cancellation.

Table II-29. Acreage and production affected - onions.

States	Ave. acres planted 1975 - 1977 1/	Percentage of acres treated 1976 2/	Expected annual acres treated	Average annual production 1975 - 1977 (1,000 cwt) 3/	Percent of U.S. average production 4/	Percent of U.S. production treated in the state 5/
California	5,567	45	2,505	1,735	5.2	2.3
Michigan	7,367	64	4,715	2,021	6.1	3.9
New York	14,133	63	8,904	3,666	11.0	6.9
Texas	26,733	75	20,050	5,219	15.7	11.8

1/ Vegetables 1977 Annual Summary Crop Reporting Board, USDA.

2/ Assessment of EBDC fungicide uses in Agriculture Part II., USDA/STATE/EPA Assessment Team April 1978.

3/ Vegetables 1977 Annual Summary.

4/ Ibid.

5/ This percentage is derived from information contained in colums 2 and 5.

Table II-30a. Treatment cost per acre and total - onions

State	Ave. number of EBDC apps. per acre 1/	Active ingredient applied per acre 2/	Estimated EBDC applied per acre per season - A.I.	Estimated cost per acre with EBDC (1.90 per lb. A.I.) 3/	Estimated quantity of preferred alternative per acre - A.I. 4/	Estimated cost per acre with preferred alternative 7/	Estimated increase in cost per acre with alternative	Total cost impact for the State (1,000 dol.) 8/
Texas	3.5	2.0	7.0	13.30	4.5 5/	21.38	8.08	180.0
New York	6	2.4	14.4	27.36	10.1 5/	47.98	20.62	218.2
Michigan	8	1.2	9.6	18.24	9.0 5/	42.75	24.51	97.2
California	3.5	2.4	8.4	15.96	5.25 6/	24.94	8.98	20.2

1/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978. The specific EBDC fungicide used is maneb.

2/ Ibid.

3/ The estimated average price of EBDC fungicides is $1.90 per lb. a.i. The price of EBDC is an average derived from several price lists.

4/ Assessment of EBDC Fungicide Uses in Agriculture, Part II.

5/ Chlorothalmil would be the preferred alternative.

6/ Anilazine would be the preferred alternative.

7/ The estimated average price for Chlorothalmil is $4.75 and for Anilazine the price is $5.70 per lb. a.i. The prices are derived from several price lists.

8/ Vegetables 1977 Annual Summary, Crop Reporting Board, USDA.

Table II-30b. Impacts on production cost - onions

State	Proportion of U.S. production treated in the States 1/	Ave. Revenue per acre 1975-77 (est. ave. cost) 2/	Increase in material cost with alt. fungicide 3/	Est. percent change in cost per acre	Est weighted percent impact on U.S. ave. production cost 4/
		dols.			
California	0.023	1,994	8.08	0.4	0.01
Michigan	0.039	2,374	20.62	0.9	0.04
New York	0.069	2,287	24.51	1.1	0.08
Texas	0.118	2,573	8.98	0.3	0.04
Total	0.249				0.17

1/ Source: Vegetable 1977 Annual Summary. Crop Reporting Board, USDA. The proportions are obtained by dividing the percentages in the right most column of Table II-7 by 100. The total 0.249 represents the proportion of U.S. production treated.

2/ Source: Ibid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the Appendix.

3/ Source: See Table II-30.

4/ Each item in the column represents the percentage impact on U.S. production cost originating in the state. The column total, 0.17, represents the weighted percent change in average U.S. production cost of the commodity that would result from an EDBC cancellation.

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING EBDC USE ON LIMA BEANS

A. USE: EBDC use on commercially grown lima beans.

B. MAJOR DISEASE CONTROLLED: Downy mildew

C. ALTERNATIVES:

Major registered chemicals: Copper

State recommendations: In recommendations for beans, 17 states list EBDCs. Two states list copper as an alternative. Fifteen states including the states with likely impacts (Delaware, Maryland, and New Jersey) list no alternatives to EBDC's.

Non-chemical controls: Effective non-chemical control methods are not available.

Efficacy of alternatives: In the heavily affected states of Delaware, Maryland, and New Jersey, the alternative fungicide, copper, does not give economic control of downy mildew on lima beans.

Comparative performances: Coppers are less effective in controlling downy mildew than is the EBDC fungicide maneb.. Coppers also are phytotoxic to lima beans. Economic control of downy mildew of lima beans in Delaware, Maryland, and New Jersey could not be obtained with coppers.

Comparative costs: Growers would not shift to other fungicides therefore saving the $6.08/acre chemical cost and approximately $10.00 /acre in application costs.

Conclusion: Growers in Delaware, Maryland, and New Jersey would not treat for downy mildew if EBDC's were unavailable. Losses would occur in 5 out of every 10 years. In years of disease infestation, yield losses would average 50%.

D. EXTENT OF USE: Expected number of acres treated annually would be 3,070, 1,070, and 670 in Delaware, Maryland, and New Jersey, respectively. The acres treated figures are based on the estimates that 60% of lima bean acreage is treated when downy mildew infestations occurs and the infestations occur in 5 years out of 10.

E. ECONOMIC IMPACTS:

User: Expected loss in total revenue would average $28-$32 per acre based on current prices. A nationwide price increase of about 2% could occur and reduce the loss in total revenue by $5-$6.

Market/Consumer: Quantity of lima beans marketed could decline by 1% for U.S. and prices could rise by 2% at farm and retail level. Consumers might pay an additional $1 million per year for processed lima beans.

Macroeconomic: None expected.

F. SOCIAL/COMMUNITY IMPACTS: Not investigated.

G. LIMITATIONS OF ANALYSIS:

1. Usage estimates were made by Assessment Team members. Survey data were not available.

Lima Beans

User Impact

Effective fungicides are important in lima bean production primarily because of one disease. This disease is downy mildew. In the States that would be affected by an EBDC cancellation (New Jersey, Delaware and Maryland), downy mildew occurs approximately 5 years out of 10.

During periods of infestation 60 percent of the aceage is treated with an EBDC fungicide. (1) Thus, the probability that an acre of lima beans in one of the affected states would be treated diring any given year would be 0.3. 35/

Alternative Control Programs

Copper is considered an alternative to the EBDC fungicides in the control of downy mildew on lima beans. However, it is recommended as an alternative in only two of the States in which lima beans are grown. It is not recommended in three affected States--Delaware, Maryland and New Jersey. (1) These States are consequently left without an alternative to the EBDC fungicides should the latter be cancelled from use.

Impact on Production Cost

Since no effective alternative fungicide is expected to be economically viable in the affected States the cancelling of the EBDC fungicides would tend to reduce the cost of production per acre. The extent of this

35/ See Table II-31 concerning this probability. The probability is merely the product of the proportion of acres treated during a year in which infestation occurs and the proportion of years out of a decade in which infestation occurs.

reduction in cost per acre is the outlay that is avoided by not using the EBDC fungicides. Table II-32 shows that this outlay per acre per season is approximately $12.16 for the three affected States of Delaware, Maryland, and New Jersey. However, it must be borne in mind that this cost is only avoided during these years in which there is an infestation of downy mildew. As indicated in Table II-31, this disease has a probability of 0.5 of occurrence in any given year. Thus, the expected cost avoided per acre per annum is $6.08.

This reduction in expected cost per acre lowers the expected cost of production per acre for the entire U.S. This effect on the expected average cost per acre for the entire U.S. must be taken into account in assessing the change in the market price of lima beans that would occur because of a cancellation on the use of EBDC's. In making the estimate of the percentage decrease in production cost in each State, the revenue per acre (average 1975-77) is used as a basis for the estimation of long-run average cost of production. The rationale and assumptions inherent in this approach are outlined in the section on fresh market tomatoes and in the Appendix. The estimated average costs per acre in Delaware, Maryland and New Jersy are $179, $193 and $183 respectively (Table II-32b). A cost decrease per acre of $6.08 would mean a percentage decrease of 3.4 percent in Delaware, 3.1 percent in Maryland and 3.3 percent in New Jersey (Table II-32b). In the table, each of the percentages is weighted by the proportion of U.S. production accounted for by the respective States. The sum of these weighted percentages is equal to 0.153 (Table II-32b). This estimate is the percentage reduction in average U.S. production cost of lima beans

that would result from a cancellation of the EBDC fungicides. This percentage is used below to estimate the impact on U.S. market price of lima beans.

Changes in Yield, Quality and Production

Significant reductions in yield would result from a cancellation in the use of EBDC fungicides on lima beans. Table II-32b shows that the expected reduction in yield in the three affected States would be approximately 25 percent of the average yields attained over the period 1975-1977. There would be a 50 percent reduction during those years in which infestation occurs. However, infestation has a probability of 0.5 in any given year. Thus, the expected loss in yield is 25 percent, not 50 percent.

The estimated production lost because of these reductions in yield must necessarily take account of the probability of infestation in any given year. That is, the expected percentage loss in yield in each of the three affected states must be weighted by the expected proportion of total U.S. production treated in the State. The expected percentage loss in yield in each of the affected states is 25 percent (Table II-32a). The expected proportion of total U.S. lima bean production treated in each of the these affected States is shown in the left most column of Table II-32b. If the 25 percent yield loss that would occur in each of the affected States is weighted by the respective proportion of U.S. production treated in the State, one obtains an estimate of the percentage reduction in U.S. supply originating in the State. The sum of these weighted percentages is 1.154 (Table II-32b). This percentage is the total percentage reduction in U.S. supply that would result from cancellation of the EBDC fungicides. This percentage

[illegible] a cases, losses of [illegible]

[illegible] below to estimate the impact [illegible]

Quality and Production

[illegible] ant reductions in yield [illegible]

[illegible] fluctuates on its basis. The [illegible]

[illegible] ction in yield in the three affected [illegible]

[illegible] ly 25 percent of the [illegible]

[illegible] its would be [illegible] percent [illegible]

[illegible] duction occurs [illegible]

[illegible] given year. Thus, [illegible]

[illegible] mated production for [illegible] because [illegible] reductions [illegible]

[illegible] ly take account of [illegible]

[illegible] That is, the expect[illegible]

[illegible] affected states were [illegible] expected [illegible]

[illegible] total U.S. production treated in the States. [illegible]

[illegible] loss in yield in each of the [illegible]

[illegible] II-12a). The expected production in total U.S. [illegible]

[illegible] treated in each of the three affected [illegible]

[illegible] column of Table II-12b. If the 25 percent yield loss

[illegible] in each of the affected states [illegible]

[illegible] portion of U.S. production treated in [illegible] states, and obtain

[illegible] reduction in U.S. supply [illegible]

[illegible] ated percentages [illegible] Table II-12c).

[illegible] reduction in U.S. supply [illegible]

[illegible] fungicides. This percentage

is used below to estimate the impact on U.S. market price of lima beans. An expected loss in output of 1.15 percent (rounded) for the U.S. would be expected from an estimate based on the above described weighted average. The average annual U.S. production for the period 1975-1977 was 75,367 tons. (2) This number would represent the base in the use of the percentage 1.15. Thus, the expected annual reduction in U.S. output of lima beans would be 868 tons. However, this reduction would be that expected at the average U.S. price (for this period) of $319.91 per ton. To the extent that this price shifts upward, the reduction in output would be mitigated. These adjustments will be addressed below.

Change in Commodity Prices and Farm Income

The extent of the expected price change for lima beans would depend on the extent of the reduction in output and the extent of the reduction in production cost. As noted above, the decrease in production cost is relatively small (0.15 percent). However, for the purpose of making a more accurate approximation of the expected price change at the farm level, this change in production cost will be taken into account. The estimate of expected price change must also take into account the estimated elasticities of demand and supply.

The estimated price elasticity of demand that will be used in this assessment is equal -0.42. 36/ The price elasticity of supply at the farm level has been estimated to be equal to 0.10. This number means that a one percentage change in the price of lima beans will generate a 0.10 percentage change in the quantity supplied. (14)

The estimated percentage change in the market price of lima beans that would result is 2.18 percent. 37/

36/ This elasticity is an estimate derived from the study by P.S. George and G.A. King titled Consumer Demand for Food Commodities in the United States With Projections for 1980. The elasticity of demand at the retail level, the estimate of the elasticity of demand at the farm level requires some information regarding the elasticity of price transmission. The elasticity of price transmission is a ratio which measures the percentage response of the retail land price in response to a percentage change in price at the farm level. The transmission elasticity is also equal to the ratio of the farm level price elasticity over the retail level price elasticity. The elasticity of demand at the farm level is thus equal to the arithmetic product of the retail level price elasticity and elasticity on the elasticity of price transmission for this commodity group, there is information on the elasticity of price transmission for canned peas and for canned tomatoes. The average of these two elasticities is 1.06. Thus the farm level price elasticity is equal to 0.424=(1.06) (.4).

37/ This estimate is derived through the use of the following formula:

$$\% \text{ change in price} = \frac{(1.15) - (0.10)(0.15)}{(0.42 + 0.10)}$$

$$= 2.181$$

1.15 = the change in production or supply, this percentage was derived above (Table II-32b)
0.15 = estimated percent reduction in average cost per acre and per ton for lima beans (Table II-32b)
0.42 = the estimate of the from level demand elasticity
0.10 = the elasticity of supply used in this assessment

The formula used above is an algebraic sum of two formulas developed and explained in the Appendix. See the Appendix for further information on the appropriate use of the formulas and the assumptions inherent in their use.

The expected percentage change in price exceeds one percent. Since the percentage exceeds this threshold, an estimate will be made of the change in total income that will accrue to growers in the U.S. The designated threshold of one percent in the price change is in accordance with the procedure outlined in the Introduction to the vegetable section.

The percentage change in total income would be determined by the percentage change in price and the percentage change in quantity. A percentage change of 2.18 percent would mean an increase from $319.91 to $326.88. The price $319.91 is the average annual price for the period 1975-1977. The percentage change in the quantity sold would be a product of the farm level price elasticity (-0.42) and the estimated expected percentage change in price at the farm level (2.18 percent. This percentage is -0.92 percent. The average annual quantity of lima beans marketed for the years 1975-77 was 75,367 tons. A reduction of 0.92 percent would reduce this average annual quantity marketed to 74,674 tons. This change in average annual price and the average annual quantity marketed would increase the total income accruing to all U.S. lima bean growers from $24,110.3 thousand to $24,409.4 thousand.

In the preceeding paragraph, note should be taken of the fact that the reduction in output (from the original average annual level) is 693 ton for the U.S. as a whole. This is the net reduction in output that occurs as the market for lima beans shifts from one "equilibrium price." The number 693 clearly differs from the reduction in output to which reference was made in the section on "Changes in Yield Quality and Production." The reduction in output mentioned earlier was 868 tons for the U.S. as a whole. This latter number would be the immediate impact of the

EBDC cancellation. No allowance is made in this estimate for adjustment in price or for adjustment to changes in price. The higher price that would be induced by the initial reduction in output would tend to encourage production so that the output effect of the EBDC cancellation would be mitigated to some extent.

The change in total income accruing to growers in the three affected States would depend on the extent by the expected yield reduction, the expected change in price and the expected reduction in cost incurred because no alternatives are available. The following tabulation shows the current average annual yield per acre and the yield per acre that would be expected on the average that would be affected by an EBDC cancellation.

	Ave. Yield Per Acre 1975-1977 tons	Expected Yield on Attected Acres After Cancellation tons
Delaware	0.72	0.54
Maryland	0.70	0.53
New Jersey	0.75	0.56

The numbers in the right column of the tabulation reflect the yield reduction that would be expected on 30 percent of the acreage. This latter percentage would be the expected part of the lima bean crop that would be treated during a given year.

The average price of lima beans in each of the three affected States will differ somewhat from the average annual price derived for the total U.S., -$319.91. The following tabulation shows the average annual price for each State based on the data for 1975 through 1977.

	Aveage annual price 1975-1977	Expected price per ton
Delaware	$248.66	$254.08
Maryland	277.04	283.36
New Jersey	244.04	249.36

The right column shows the price that would emerge in each State after an increase of 2.18 percent. This percentage is the change estimated fungicides were cancelled.

A comparision of current and expected total revenue per acre is given in the following listing.

	Total revenue per acre (average 1975-1977)	Expected total revenue per acre after EBDC cancellation
Delaware	$179.00	(0.54)(254.08)=$137.20
Maryland	193.00	(0.53)(283.36)= 150.18
New Jersey	183.00	(0.56)(249.36)= 140.00

The estimates of total revenue per acre in the right column are obtained from the arithmetic product of the expected price per ton for lima beans and the expected yield per acre in each of the three States. These expected values are those estimated to hold after the imposition of a cancellation on the use of EBDC fungicides on lima beans.

The loss per acre in these States is not measured solely by the difference between the average annual revenue per acre for the period 1975-77 and the expected revenue per acre after an EBDC cancellation. Since no alternative fungicide is available to replace EBDC fungicides on this crop, a ban on its use will result in a reduction in cost. The reduction

in cost would reduce the losses per acre that would be incurred by affected growers. The following tabulation shows the net losses that would be incurred per acre (on the affected areage) in the three affected States.

	Net loss per acre on affected acreage
Delaware	$ 35.01
Maryland	36.52
New Jersey	36.36

This listing is obtained by subtracting the cost per acre for EBDC fungicides given in Table II-32a from the loss in total revenue per acre on the affected acreage in each of the three States.

A certain proportion of the lima bean acreage in the three affected States would be allocated to the production of other crops. A decline in the acreage in all of the producing States would be expected to follow the decline in the total quantity produced and marketed. This decline would result from the upward shift in the equilibrium price induced by the initial reduction in supply. As on this above, it is estimated that there would be 0.92 percent reduction in the quantity of lima beans produced and marketed in the U.S. once adjustment to price change is taken into account. It is assumed that the 0.92 percent estimate can be used to estimate the percentage reduction in lima bean acreage in the three afffected States of Delaware, Maryland, and New Jersey. The estimated acreage reductions would be 94 acres for Delaware, 33 acres for Maryland, and 21 acres for New Jersey. These acreage figures for each State represent those acres that would switch to alternative crops. The following listing

shows the expected total acres in each State and the expected acres on which losses would be incurred.

	Expected average annual acres planted after adjustment to price change	Expected acreage incurring losses
Delaware	10,139	3,042
Maryland	3,534	1,060
New Jersey	2,226	668

The acres listed on the right would represent the acreage on which the above mentioned losses would be incurred. The acres listed on the left are those on which a net gain would be obtained because of the 2.18 percent increase in the price of lima beans. The net gains and net losses in each State are given in the following listing.

	New gain on the unaffected acreage	Total losses on the affected acreage	Net loss imposed in the affected States
Delaware	$39,566	$106,500	$66,934
Maryland	14,966	38,711	23,745
New Jersey	8,881	24,288	15,407
Total	63,413	169,499	106,086

The net losses imposed at the farm level in the three affected States is $106,086. The gain in total income to growers in the remaining parts of the U.S. is $235,687. Thus, the net gain in total revenue to lima bean growers in the total U.S. is $129,601.

Consumer Impact

Changes in Quantity and Quality of the Product Available

As noted above, a cancellation on the use of EBDC fungicides would affect yields in the three States—Delaware, Maryland and New Jersey. The consequence of these reductions in yields would be to reduce expected annual U.S. production by 1.15 percent. However, this percentage would be reduced somewhat once the price of lima beans shifts upward in response to the initial reduction in output.

The quality of lima beans marketed would not be affected by a cancellation on EBDC fungicides.

Change in Consumer Expenditure

It is estimated that the farmers share of the retail price for selected process vegetables is approximately 15.0 percent. (11)

The average annual farm level price given above was $319.91 per ton for the period 1975-1977. The average annual price per pound at the farm limit would be approximately $0.16. This farm level price per pound would represent 15 percent of the dollar value $10.7. This latter dollar amount would be the average price at the retail level as estimated on basis of the farm level price for 1975-1977. Estimated percentage increase in price at the retail level would necessarily take account of the percentage change in price at the farm level and the responsiveness of retail level prices to change in farm level price. The percentage change in price for lima beans at the farm level is expected to be 2.18 percent if the EBDC fungicides are cancelled for use on this crop. Also, estimates show that the retail price of selected canned vegetables

increase an average 1.06 percent for every one percent increase in price at the farm level. 38/ Thus, the expected percent change in the retail price of lima beans is 2.3 percent. 39/ After such a change, the expected average annual retail level price of lima beans would be $1.10 per pound.

The average annual quantity of lima beans marketed for the period 1975-77 was 75,367 tons. At an estimated price of $1.07 per lb., the total annual outlay made by consumers for lima beans was approximately $161.3 million. If the EBDC fungicides were cancelled the quantity that would be marketed per year (after adjustment to higher prices) would be 74,674 tons. At a retail price of $1.10 per pound, this quantity of lima beans would cost American consumers $164.3 million. Consquently, an EBDC cancelled would result in an additional outlay of $3.0 million on the part of U.S. consumers of lima beans.

38/ This is the average for two canned vegetables in the study by P.S. George and G.A King cited above. The two vegetables are canned peas and canned tomatoes. Their respective elasticities of price transmission are 0.979548 and 1.130774.

39/ This estimate is an arithmetic product of the percentage 1.06 percent and the percentage 2.18 percent.

increase an average 1.06 percent for every one percent increase in price at the farm level. 38/ Thus, the expected percent change in the retail price of lima beans is 2.3 percent. 39/ After such a change, the expected average annual retail level price of lima beans would be $1.10 per pound.

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38/ This is the average for two canned vegetables in the study by P.S. George and G.A King cited above. The two vegetables are canned peas and canned tomatoes. Their respective elasticities of price transmission are 0.979548 and 1.130774.

39/ This estimate is an arithmetic product of the percentage 1.06 percent and the percentage 2.18 percent.

Table II-31. Acreage and Production Affected - Green Lima Beans

State	Ave. acres planted 1975 - 1977 1/	Percent acres treated during a year of downy mildew infestation 3/	Average number of years out of 10 in which downy mildew occurs 4/	Probability that an acre will be treated during a season	Expected annual acres treated with EBDC 6/	Average annual production 1975 - 1977 (1,000 cwt) (Tons)	Percent of average annual U.S. production	Expected percent of U.S. production treated in the state
Delaware	10.233	60	5	.3 5/	3,070	7,383	9.8	2.9
Maryland	3,567	60	5	.3	1,070	2,484	3.3	1.0
New Jersey	2,247 2/	60	5	.3	674*	1,685 7/	2.2	0.7

1/ Vegetables 1977 Annual Summary Crop Reporting Board USDA.

2/ Estimate derived through personal communication with Dr. James Kantzes, Plant Pathologist, University of Maryland and member of the EBDC Assessement Team.

3/ Assessment of EBDC Fungicide Uses In Agriculture Part II, USDA/STATE/EPA.

4/ Estimate provided by Dr. James Kantzes.

5/ This probability is derived by multiplying 0.6 and 0.5.

6/ This estimate is obtained by multiplying the average number of acres planted by the probability.

7/ This estimated average was derived by multiplying the combined average yield per acre in Delaware and Maryland by the estimated average acreage in column 1. The combined average yield per acre in Delaware and Maryland was 175 tons per acre during the period 1975 to 1977. The source data used for these yield estimates are found in the U.S.D.A. publication titled, Vegetables 1977 Annual Summary, Acreage, Yield, Production and Value: Crop Reporting Board, ESCS.

Table II-32a. Treatment Cost Per Acre - Green Lima Beans

State	Ave. number of EBDC applications per acre 1/	Lbs. active ingredient applied per acre per application 2/	Estimated EBDC A.I. applied per acre per season 3/	Estimated materials cost per acre with EBDC 4/	Percent yield loss without treatment with an effective alternative fungicide 5/	Estimated dollar loss per acre because of yield 6/	Total revenue per acre (average 1975 - 1977) 7/	Net difference between dollar yield loss and cost of materials	Net loss per acre as a percent of total revenue per acre
Delaware	4	1.6	3.2	6.08	25	44.75	179.00	38.67	21.6
Maryland	4	1.6	3.2	6.08	25	48.25	193.00	42.17	21.8
New Jersey	4	1.6	3.2	6.08	25	45.75	183.00	39.67	21.7

1/ Assessment of EBDC fungicide uses in Agriculture, Part II, USDA/STATE/EPA Assessment Team, April 1978.

2/ Ibid.

3/ This estimate is based on the assumption that downy mildew will be a problem in 5 years out of the average 10 year period.

4/ The estimated price per Lb. for EBDC fungicides is $1.90. The price is an average derived from several current price lists.

5/ Though copper is registered for this crop, it would not be used if the EBDC's were suspended.

6/ This amount would be 50 percent of total revenue per acre.

7/ Vegetables 1977 annual summary, crop reporting board, USDA.

Table II-32b. Impacts on production cost and production - green lima beans

State	Proportion of U.S. production treated in the State 1/	Average revenue per acre 1975-77 (Est. average cost) 2/	Decrease in material cost with alternative fungicide 3/	Estimated percent change in cost per acre	Estimated weighted percent impact on U.S. average production cost 4/	Estimated expected percent yield loss per acre in the State 5/	Estimated weighted percent reduction in U.S. supply 6/
Delaware	0.029	$179	$6.08	3.4	0.099	25	0.73
Maryland	0.010	193	6.08	3.1	0.31	25	0.25
New Jersey	0.007	183	6.08	3.3	0.023	25	0.174
Total	0.046				0.153		1.154

1/ Source: Vegetable 1977 Annual Summary, Crop Reporting Board, USDA. The proportions are obtained by dividing the percentages in the rightmost column of Table II-31 by 100. The total represents the proportion of U.S. production treated.

2/ Source: Ibid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the Appendix.

3/ Source: See Table II-32a.

4/ Each item in the column represents the percentage impact on U.S. production cost originating in the State. The column total, 0.153, represents the weighted percent change in average U.S. production cost of the commodity that would result from an EBDC cancellation.

5/ Source: See Table II-32a.

6/ Each item in the column represents the percentage reduction in U.S. output that originate in the State. The column total, 1.154, represents the weighted percent change in U.S. production.

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING
EBDC USE ON FRESH SNAP BEANS

A. USE: EBDC use on commercial fresh snap bean production

B. MAJOR DISEASES CONTROLLED: Authracnose and rust

C. ALTERNATIVES:

Major registered chemicals: chlorothalonil for rust

State recommendations:

	Number States Recommending for Diseases	
	Anthracnose	Rust
EBDC	23	31
Chlorothalonil	2	21
Captan*	2	1
Cooper	2	3
No alternatives recommended	16	4

* = RPAR Chemical

Non-chemical controls: Non-chemical control methods do not provide adequate control in Florida.

Efficacy of alternative: Chlorothalonil would provide equivalent disease control.

Comparative performance: Yields and quality would be maintained if chlorothalonil were substituted for EBDC.

Comparative costs:

	Season Chemical Cost Per Acre		
	EBDC	Chlorothanlonil	Difference
Florida1/	$13.22	$62.22	$49.00

1/ An average of 5.8 applications per season

Conclusion: Chlorothalonil is registered and recommended by several states for rust control. The treatments for rust will also provide any control needed for anthracnose. Yields and quality should be maintained in Florida although treatment costs would increase five-fold.

D. EXTENT OF USE:

Active ingredient basis: Commercial fresh snap bean producers in Florida apply 457,500 pounds EBDC (active ingredient) on 37,500 acres. Commercial producers in other states generally do not use EBDC.

Units treated basis: 37,500 acres in Florida are treated annually. These acres represent 97% of Florida production and 40% of total U.S. production of fresh market green beans.

E. ECONOMIC IMPACTS:

User: Chemical costs would increase by $49,000 per acre for Florida growers. This cost increase represents 7.6% of the U.S. average revenue per acre. Since 40% of U.S. green bean production is treated, average U.S. production costs would rise by 3.0%. Cost increases would induce a price rise which would increase total revenue to green bean growers by $1.4 million ($468 thousand going to growers in Florida). Since all cost increases occur in Florida ($1.8 million), the net impact would be $1.347 million loss in that state. Some Florida growers might leave green bean production.

Market: Production cost increases would result in 0.36% reduction in quantity of green beans marketed. Prices at farm level would increase by 2.44%. Production of green beans in Florida may decline slightly.

Consumer: Consumer prices are expected to increase by $0.01 per pound or 2.24%

Macroeconomic: None expected

F. SOCIAL/COMMUNITY IMPACTS: Not Investigated

G. LIMITATIONS OF ANALYSIS: This analysis relied on usage data provided as expert opinion by the EBDC Assessment Team members. Formal user survey data were not available.

H. PRINCIPAL ANALYST AND DATE:

John Bratland, USDA
Gary Ballard, EPA
September, 1978

Snap Beans

An EBDC cancellation on snap beans would have most of its impact in the state of Florida. As indicated in the biological report, there are two primary diseases that affect this crop in humid climates (1). These are bean anthracnose and bean rust. Both are effectively and economically controlled with the EBDC fungicides.

As shown in Table II-33, Florida accounts for 41.7 percent of the U.S. production of snap beans. Since 97 percent of the snap bean acreage is treated with EBDC's in Florida, approximately 40 percent of total U.S. productions treated with EBDC's within this State as shown in Table II-33.

Alternative Control Programs

Table II-34a shows that chlorotahalonil is the fungicide that would be preferred as an alternative if the use of EBDC fungicides were cancelled on snap beans. Chlorothalonil would apparently be used on all of the acreage in Florida on which the EBDC fungicides are currently used. However, chlorothalonil is only registered for use against the bean rust. Chlorothalonil would be applied on an average of 5.8 applications during a growing season in a total amount of 13.1 lbs.(a.i.) per acre per season. On the other hand, the EBDC fungicides are applied on an average of 5.8 applications during the growing season in a total quantity of 6.96 lbs. (a.i.) per acre per season.

Impact on Production Cost

The use of EBDC fungicides on snap beans in Florida involves an outlay per acre of $13.22. This cost estimate assumes a cost per pound of active ingredient of $1.90 per lb. (Table II-34a). Chlorothalonil is a more expensive fungicide; it has an average price per pound of active ingredient

ds. As [illegible]

that affect this crop [illegible]

anthracnose and bean rust. [illegible]

? controlled [illegible]

in Table II-31, Florida [illegible]

of snap beans. Since 97 percent [illegible]

with EBDC's [illegible]

productions treated with [illegible]

in II-33).

Common [illegible]

shows that chlorothalonil [illegible]

As an alternative [illegible]

d on snap beans. Chlorothalonil [illegible]

f the acreage in Florida [illegible]

l. However, chlorothalonil is not registered [illegible]

[illegible]. Chlorothalonil would be [illegible]

during a growing season [illegible]

per season. On the other hand, the EBDC fungicides [illegible]

of 5.0 applications during the growing season [illegible]

of 6.76 lbs. (a.i.) per acre per season.

[illegible]

[illegible] estimate [illegible]

[illegible]

of approximately $4.75. With 13.1 lbs. of chlorothalonil applied per acre per season, the total material cost per season would be approximately $62.22. Thus, the difference in material cost per acre would be $49.00. Table II-34b shows that this amount would be 7.6 percent of estimated average cost per acre.

On the 37,440 acres of snap beans treated per year on the average, the total outlay for EBDC fungicides per annum would be approximately $495 thousand. After a potential EBDC cancellation, however, snap bean growers would spend about $2.33 million for chlorothalonil. Thus, the preferred alternative fungicide would involve an additional financial outlay of $1.8 million on the part of snap bean growers in the state of Florida.

Changes in Yield, Quality and Production

There would be no change in yield or quality with the use of chlorothalonil as a substitute for the EBDC fungicides. (6)

Changes in Commodity Prices and Farm Income

The extent to which the price of snap beans would increase as a result of an EBDC cancellation will depend on the extent of the material cost increase and the responsiveness to price increases of quantities demanded and supplied. The estimate sought here is not an estimate of the change in price for Florida snap beans alone but rather an estimate of the change in price for all snap beans marketed at the farm level in the U.S.

The same theory, rationale, and assumptions as were used in the analysis of U.S. fresh market tomato prices will be employed to estimate percentage change in production cost (see the appendix to the vegetable

section) thus, the estimated average resource cost per acre in Florida $642.00 over the period 1975-77. The difference in material cost that would be incurred by snap bean growers in the state of Florida is $49.00 as shown in Table I-34a. This difference represents 7.6 percent of the estimated average cost per acre in Florida. However, Florida accounts for 40 percent of U.S. production. (2) Thus, this increase in material cost would represent an increase of 3.0 percent for all of U.S. production.

This estimated average cost change per cwt. of snap beans could be used to estimate the change in price at the farm level if supply and demand elasticities were both readily available. It is estimated that a one percent increase in the price of snap beans will reduce the quantity demanded by 0.23 percent. Thus, the elasticity of demand for snap beans is said to be equal to -0.23. (11) Unfortunately, estimates of the supply elasticity for snap beans are not available. However, one can determine a likely upper limit for the supply elasticity on the basis of supply elasticities of other fresh market vegetables. A recent study of supply response to price shows that no fresh market vegetable has a supply elasticity that exceeds or approaches 1.0. Nearly all fresh market vegetables have estimated elasticities of supply much smaller than 1.0. (4) With the use of a relatively high elasticity of supply, a per acre cost increase would result in a higher estimate of the extent of induced price increase. Thus, if one uses a realistic upper limit for the elasticity of supply for snap beans, one can derive an upper estimated of the percentage change in price that would be associated with a certain percentage change in cost. For the purpose of estimating this upper limit for the change in the price of snap beans, a supply elasticity of 1.0 will be used.

As indicated above, both the demand and supply elasticity would be used in determining the extent of a change in price of snap beans. With a 3.0 percent average increase in production cost for the U.S., the estimated maximum change in U.S. price would be 2.44 percent at the farm level 40/. Since this estimated maximum change in price exceeds one percent, an estimate will be made of the change in total revenue that would accrue to growers because of the price increase. This procedure is in accord with the methodology specified in the Introduction to the vegetable section. The average U.S. price for snap beans over the period 1975-1977 was $20.07 per cwt. An increase of 2.44 percent would bring this price up to $20.56.

With the increase in price of 2.44 percent, there would be a decrease in the quantity of snap beans marketed. The extent of this decrease would be 0.56 percent. 41/ Over the period 1975-77 the average annual quantity of snap beans marketed was 3,057,667 cwt. A reduction of 0.56 percent would reduce this quantity to 3,040,544.

40/ This estimate would be derived through the use of the following formula:

$$\%\text{ change in price} = \frac{3.0}{1 + \frac{0.23}{1.0}} = \frac{3.0}{1 + 0.23} = 2.44$$

3.0 = The percentage change in average cost per cwt. for the the

0.23= The price elasticity of demant used for snap beans in this assessment.
1.0 = The assumed upper limit on the elasticity of supply for snap beans

See the Appendix for further information on the appropriate use of the formula and the assumptions inherent in its use.

41/ This percentage is determined by multiplying the elasticity of demand by the percentage change in price determined above.

0.56% = (0.23) (2.44).

The importance of the above described adjustments in quantity and price attaches to the change in revenue that accrues to growers. For the U.S. as a whole, the average annual total revenue received by growers would increase from $61,367,377 to $62,513,585. The increase in total revenue of about $1,446.2 thousand would accrue to all growers in the U.S, not just those in Florida.

In assessing the effect of the price increase in Florida, the assumption will be made that the same percentage adjustments will apply to Florida prices and quantities marketed. The average weighted price of snap beans in Florida over the period 1975-77 was $19.65. 42/ An upward adjustment in this price of 2.44 percent would increase this price to $20.13. A reduction in the quantity of snap beans marketed of 0.56 percent would mean a downward adjustment from 1,274,000 cwt. per annum to 1,266,866 cwt. Thus, the total annual revenue received would increase from the average annual amount of $25,034,100 to $25,502,013. This change in total revenue would represent an increase in annual revenue of about $467.9 thousand for Florida snap beans growers.

The increase in total revenue accruing to Florida snap bean growers mitigates the negative economic impact of the increased materials cost. This total cost increase faced by Florida growers would amount to approximately $1,834.6 thousand. 43/ Thus, the net loss incurred by growers in this one affected State would be about $1,366.6 thousand.

42/ This price was obtained by multiplying the revenue per acre in Table II-34b by the average annual acreage planted in Table II-33. This arithmetic product was divided by the average annual production for the period 1975-77. This production data is also found in Table II-33.

43/ This figure is obtained by multiplying the acres treated by the added material cost per acre.

The net loss for the U.S. would necessarily take account of the increase in total revenue accruing to growers outside of Florida. This increase is approximately $978.3 thousand. This estimate is obtained by subtracting $467.9 thousand (the increase in total revenue accruing to Florida growers) from $1,446.2 thousand (the increase in total revenue accruing to all U.S. snap bean growers). Thus, the net loss for the U.S. as a whole is about $388.4 thousand.

Impact on Net Return

The impact of an EBDC cancellation on net returns in Florida is difficult to assess. Table II-35 shows a production budget for snap beans for one area in Florida. In the Palm Beach-Broward area, the net loss for 1976-77 period is shown to be -$128.37. An increase of $49.00 per acre for alternative fungicides would increase this net loss per acre to -177.37. 44/ These losses are too large to be sustained for any extended period. Thus, there would be some acreage shift if losses of this magnitude were incurred for several seasons. However, Table II-35 shows that the yield levels for 1976-77 period are considerably below those for the 5 season average. The yield for the 5-season average (Table II-35) was 78 bushels per acre while the yield in the latter growing season was only 59 bushels per acre. With average yields, the losses per acre that would be incurred after an EBDC cancellation would not be nearly as great as those mentioned above. (9) It is expected that yields would return to normal levels after the decline reflected in the 1976-77 growing season.

44/ This estimate of losses ignores the effect of price changes for snap beans. However, an increase of 2.44 percent in price would have dramatic effect on the size of this loss per acre.

The reduced yields for the 1976-77 period are reflected in lower values for crop sales. The range of total crop sales is from $187.85 to $587.50 in the Palm Beach-Broward area (Table II-3). However, Table II-34b shows that the average annual revenue per acre for the entire State is $642.00. Thus, the yield and total revenue per acre in this area (Palm Beach - Broward) are not representative of yield and total revenue per acre for the State as a whole. It is apparent that no definite conclusions can be drawn form this budget concerning the impact of an EBDC cancellation on net returns on snap beans in Florida.

Consumer Impact

Changes in the Quantity and Quality of the Commodity Available

The use of the alternative fungicide, chlorothalonil, would have no adverse effects on the quality of snap beans marketed. The quality levels attained with the EBDC fungicides would be maintained with the preferred alternative.

Yield levels would also be maintained if chlorothalonil were used on the Florida acreage. Thus, supplies available to consumers would not be reduced to any important degree because of a cancellation of the EBDC's.

Change in Consumer Expenditure

A cancellation on the use of EBDC's on snap beans would have some effect on the total expenditure of consumers for snap beans. The estimate of this change would require some information concerning retail prices for snap beans. It is estimated tha the farmer's share of the retail price for beans is 0.434 (11). The average weighted U.S. farm level price for the period 1975-1977 was $20.07 per cwt. Thus, the estimated retail level price for the U.S. during this same period would be $46.24 per cwt.

The average annual quantity sold for the period 1975-77 was 3,057,667 cwt. (2) The estimated average annual expenditure at the retail level for this period would be $141,386,522. In order to estimate the change in this total annual expenditure level, one must determine the extent to which the retail level price changes in response to a change in the farm level price. It is estimated that for snap beans, a one percent change in price at the farm level is assoicated with a 0.919 percent change in price at the retail level. (11) Thus, the "elasticity of price transmission" is said to be equal to 0.919. From the analysis offered above, it was determined that a cancellation of the EBDC's would result in a 2.44 percent increase in the price of fresh market snap beans at the farm level. One would obtain the estimated percentage increase at the retail level by deriving the arithmetic product of the elasticity of price transmission, 0.919, and the percentage change in price at the farm level, 2.44 percent. This product is a 2.24 percentage increase in the price of snap beans at the retail level. An increase of 2.24 percent would increase the price of snap beans from $46.24 per cwt. to $47.28 per cwt. This price increase of 2.24 percent would be paid by consumers for an estimated U.S. total quantity of 3,040,544 cwt. per annum. Consequently, the estimated total outlay that would be made by consumers for fresh market snap beans would be $143,756,920. This number would represent an additional outlay by consumers of $2,370,398.

Table II-33. Acreage and production affected - Green Beans

State	Average acres planted 1975 - 1977 1/	Percent acres treated - EBDC 1976 2/	Expected annual acres treated with EBDC	Average annual production 1975 - 1977 (1,000 cwt) 3/	Percent of average U.S. production 1975 - 1977 4/	Percent of U.S. production treated in the state 5/
Florida	39,000	96	37,440	1,274	41.7	40.0

1/ Vegetables, 1977 Annual Summary Crop Reporting Board, USDA.

2/ Assessment of EBDC Fungicide Use In Agriculture, Part II USDA/STATE/EPA Assessment Team, April, 1978.

3/ Vegetables 1977 Annual Summary Ibid.

4/ Ibid.

5/ This percentage is derived from column 2 and 5 in this table.

Table II-34a. Treatment cost per acre and total - green beans

State	Ave. number of EBDC applications per acre 1/	Lbs., active ingredient applied per acre per application 2/	Estimated EBDC A.I. applied per acre per season	Estimated materials cost per acre with EBDC fungicides 3/	Estimated quantity of preferred alternative used per acre per season (units A.I.) 4/	Estimated materials cost per acre with the preferred alternative 5/	Difference in material cost per acre with alternative	Total cost impact for the State (1,000 dol.) 6/
Florida	5.8	1.2	6.96	13.22	13.1	62.22	49.00	1,834.6

1/ Assessment of EBDC Fungicide Use in Agriculture, Part II, USDA/State/EPA Assessment Team, April, 1978. The specific EBDC fungicide used is maneb.

2/ Ibid.

3/ The estimated average price of the EBDC fungicides is $1.90 per lb. a.i. The price for EBDC is an average derived from several current price lists.

4/ Chlorothalonil would be the alternative used; Source: Assessment of FBDC Fungicide Use in Agriculture, Part II.

5/ The price of Chlorothalonil ($4.75) is an average derived from several current price lists.

6/ These estimates are the arithmetic products of the acres treated (Table II-33) and the difference in material cost per acre with the alternative.

Table II-34b. Impacts on production cost - green snap beans

State	Proportion of U.S. production treated in the States 1/	Ave. Revenue per acre 1975-77 (est. ave. cost) 2/	Increase in material cost with alt. fungicide 3/	Est. percent change in cost per acre	Est weighted percent impact on U.S. ave. production cost 4/
		dols.			
Florida	0.4	642.00	49.00	7.6	3.0

1/ Source: Vegetable 1977 Annual Summary. Crop Reporting Board, USDA. The proportion is obtained by dividing the percentages in the right most column of Table II-33 by 100.

2/ Source: Ibid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the Appendix.

3/ Source: See Table II-34a.

4/ Each item in the column represents the percentage impact on U.S. production cost originating in the state.

Table II-35. Snap Beans: Costs and returns in the Palm Beach-Broward area 5-season average 1972-76 and 1976-77

Item	5-season average	1976-77	
Number of growers	7	6	
Number of acres	7861	5505	
Average acres per grower	1123	918	
Average yield per acre (bushels)	78	59	
Growing costs:			
		Average per	
	Acre	Acre	Bushel
Land rent	$ 36.95	$ 43.09	
Seed	29.51	39.99	
Fertilizer	61.42	59.25	
Spray and dust	29.24	40.67	
Cultural labor	41.22	65.13	
Machine hire	14.76	10.64	
Gas, oil and grease	13.81	18.07	
Repair and maintenance	16.48	28.13	
Depreciation	12.06	14.46	
Licenses and insurance	10.20	16.25	
Interest on production capital (9% - 4 months)	7.79	9.98	
Interest on capital invested (other than land)	1.81	2.17	
Miscellaneous expense	6.18	6.26	
Total growing cost	281.43	359.11	$ 6.087
Harvesting and marketing costs:			
Picking and packing expense	77.11	72.93	1.236
Containers	47.34	44.17	.749
Hauling	10.88	9.64	.163
Selling	12.80	11.56	.196
Total harvesting and marketing cost	148.13	138.30	2.344
Total crop cost	429.56	497.41	8.431
Crop sales	440.15	369.04	6.255
Net return	$ 10.59	$-128.37	$-2.176

	1976-77 range per acre	
	From	To
Yield (bushels)	33	94
Total growing cost	$ 234.54	$ 482.33
Total harvesting and marketing cost	71.70	213.54
Total crop cost	353.41	695.87
Crop sales	187.85	587.50
Net return	$ -241.30	$ -14.67

Source: D. L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 with Comparisons, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, March 1978.

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING EBDC USE ON GREEN PEPPERS

A. USE: EBDC use on commercially produced green pepper production.

B. MAJOR DISEASES CONTROLLED: *Phytophtora* blight (Late Blight), Frogeye Spot (Cercospera) Anthracnose

C. ALTERNATIVES:

Major registered chemicals: Copper, captan

State recommendations:

	Number of States Recommending for Diseases		
	Anthracnose	Late Blight	Frogeye Spot
EBDC	17	3	12
Copper	1	1	1
Captan	6	0	5
No alter. recommended	8	2	6

Non-chemical controls: Effective non-chemical control methods are not available.

Efficacy of alternatives: Copper is considered to be the best alternative to EBDC. Copper is effective only against frogeye spot. Copper is not effective against anthracnose and phytophora blight in Florida.

Comparative performance: Copper has a more limited spectrum of diseases controlled than EBDC. Yields in Florida on EBDC treated acreage may decline by 19% should copper be used in place of EBDC.

Comparative costs: In Florida, season treatment cost for an average of 7.6 applications would be $53.20/acre as compared to $17.33/acre for EBDC. As indicated above, equivalent control would not be maintained.

Conclusion: The primary substitute to EBDC for green peppers is copper. Copper is recommended for only 1 of 3 major diseases of peppers in Florida. Overall disease is expected to decline with a resulting 19% yield reduction. Cost of treatment will increase by $36.00/acre.

D. EXTENT OF USE:

Active ingredient basis: Approximaty 120,000 lbs EBDC are used annually in Florida. Minimal amounts of copper are now used.

Units treated basis: 12,800 acres in Florida (69% of planted acreage) are treated annually with an average of 7.6 applications. Treated acreage in Florida accounts for 5.2% of U.S. production.

E. ECONOMIC IMPACTS:

User: Yield loss on treated acreage would reduce revenue by $412/acre. Adding increased treatment cost of $36.00/acre reduces cash flow by $448/acre or 21% of present revenue. Reduced production might induce a price rise which would offset some portion of this loss. Growers would shift to other crops depending upon the decision to keep or cancel EBDC use on other vegetables. The total dollar loss to users in Florida at current prices would be $5.28 million.

Market: Loss of production in short run would be 13.1% in Florida (5.2% of U.S. production). This loss is projected to induce a long run price increase of 14% ($2.34/CWT) at the farm level. Gross revenue to pepper growers in U.S. would rise $10.6 million on an annual basis.

Consumer: Quantity of green peppers available would be reduced 1.6% and prices would rise by 14% in the long run after adjustments by growers.

Macroeconomic: None expected.

F. SOCIAL/COMMUNITY IMPACTS: Not investigated.

G. LIMITATIONS OF ANALYSIS: Yield loss estimates are based on historical yields before and after widespread use of EBDC on peppers. Test data are not available to confirm loss estimates.

Usage of EBDC was estimated by Assessment Team. Survey data were not available.

Effect of cancellation of EBDC on peppers depends on decision on to cancel or not cancel EBDC use on other vegetables. The simultaneous determination of impacts has not been undertaken.

H. PRINCIPAL ANALYST AND DATE:

John Bratland, USDA
Gary Ballard, EPA
November 1978

Green Peppers

User Impact

The impact of an EBDC cancellation would be felt primarily in the State of Florida, since this state faces the most severe problems with diseases affecting this crop. Florida accounts for 35.9 percent of U.S. production of this commodity (Table II-36). Since 69 percent of the green pepper acreage in Florida is treated with the EBDC fungicides, the percentage of total U.S. production that would be affected by an EBDC cancellation is 24.8, as shown in Table II-36.

Alternative Control Program

Table II-37a shows that copper is the fungicide preferred as an alternative if the EBDC fungicides were cancelled. However, copper is recommended for use on only one of the three major diseases that affect this crop in the State of Florida. This disease is referred to as frogeye spot. (1) Apparently, copper is ineffective against anthracnose and phytophthora light.

Copper would be applied during the season with the same frequency as the EBDC fungicides. However, the total pounds of active ingredient for copper would exceed that of the EBDC fungicide used. The total quantity of EBDC fungicides applied during the season would be approximately 9.12 lbs. (a.i.) (as shown in Table II-37a) while the total quantity of copper applied during the season would be roughly 30.4 lbs. (a.i.) per acre.

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This state faces the most [illegible]

in crop. Florida accounts for 75.9 per[illegible]

[illegible] (Table II-30). Since it [illegible]

is expected [illegible]

duction that [illegible]

in Table II-4.

[illegible]ional Program:

[illegible] shows that [illegible]

the 1980 Projections were [illegible]

use on only [illegible]

State of Florida. This [illegible]

[illegible]ly, cannot [illegible]

[illegible] be applied during the season [illegible]

. However, the total [illegible] of active ingredient

that of the [illegible] fungicide used. The total

[illegible]cides applied during the season would be approxi-

(a.i.) (as shown in Table II-3[illegible]), while the

[illegible] applied during the season would be roughly

Impact on Production Cost

The use of copper instead of EBDC fungicides would increase production cost by nearly \$36.00 per acre as shown in Table II-37a. This increase would occur even though copper could be obtained by the grower at a cost of \$1.75 per lb. (a.i.) while the corresponding cost for EBDC fungicides is roughly \$1.90 per lb. 45/ This increase in cost per acre would arise because copper fungicides would be applied in the greater quantities mentioned above. Thus, the total material cost per acre with copper used as an alternative fungicide would be \$53.20 while the total per acre outlay for the EBDC fungicide is approximately \$17.33.

The estimated average annual acres treated in Florida is approximately 12,811, as shown in Table II-36. The increase in per acre cost of \$35.87 shown in Table II-37b, would mean an additional outlay in the State of \$400 thousand on the part of growers of green peppers. This estimated total outlay is based on current levels of production.

The impact of this per acre cost increase on the price of green peppers will be estimated below. The extent of this impact will depend upon the percentage change in production costs.

The same theory, rationale, and assumptions as were used in the analysis of U.S. fresh market tomato prices will be employed here to estimate percentage change in production cost (see the Appendix to the vegetable section). Thus, the estimated average resource cost per acre per annum in Florida is \$2,168 (Table II-37b). Thus, the increased cost of fungicides, \$35.87, would represent a 1.7 percent increase in production cost on affected acres in Florida (Table II-37b). When this

45/ These prices are averages from a number of current price lists.

percentage is weighted by the proportion of U.S. green pepper production treated in Florida, the arithmetic product is the weighted percent increase in the estimated U.S. cost of production. This percent increase is 0.42 percent (Table II-37b). This percentage will be used below in estimating the impact of the cost change on the price of green peppers.

Change in Yield, Quality, and Production

Table II-37b shows that there would be an expected reduction in yield of 19 percent if farmers were forced to use the copper fungicides to replace the EBDC fungicide used on this crop. This yield reduction would occur primarily because the copper fungicide is relatively ineffective against two of the three major diseases that affect green peppers in the State of Florida. Such a loss in yield per acre would imply a total production loss for the State of 246.9 thousand cwt. This estimate takes account of the fact that 69 percent of the green pepper acreage in Florida is treated with the EBDC fungicide and that the estimated 19 percent yield loss would apply only to this affected proportion of the acreage in the State.

The 19 percent yield loss that would occur in Florida is weighted by the proportion of U.S. production treated in the State. The resulting arithmetic product is an estimate of the percentage reduction in U.S. supply originating in the State. This percentage is 4.7; it will be used below to estimate the percentage change in price that would result from a cancellation of the EBDC fungicides.

Changes in Commodity Prices and Farm Income

A suspension of EBDC use on green pepper would impose an increase in material costs and a reduction in yield within the affected areas. Both the increase in material costs and the decrease in yield will generate

an increase in price. The extent of the change in price would be determined by the magnitude of the above changes and the relative responsiveness of quantities demanded and supplied when prices change. The latter magnitudes refer to the elasticities of supply and demand. The elasticity of demand for green peppers has been estimated to be approximately -0.111 (3) The elasticity of supply for green pepper has been estimated to be 0.3939 (4) Both of these elasticities can be used in a formula which takes both the change in material cost and the change in yield into account. With this formula, one would estimate a 9.6 percent increase in the price of green peppers. 46/

46/ This estimated would be based on the use of the following formula:

$$\% \text{ change in price} = \frac{4.7 + (0.43)\ (0.3936)}{0.111 + 0.3936} = 9.649$$

The following definitions apply to the above formula:

4.7 = The weighted percentage reduction in supply for the U.S. as a whole. This percentage is a weighted production of the percentage loss in yield in Florida (19.0), and the proportion of total U.S. production by Florida (0.248).

0.42 = The weighted percentage increase in production cost for the U.S. as a whole. It is an arithmetic product of the percentage increase in production cost on the affected acreage in Florida, 1.7 percent, an the proportion of total U.S. pepper production treated in Florida, (0.248)

0.3936 = The price elasticity of supply

0.111 = The price elasticity of demand

The formula used above is an arithmetic sum of two formulas developed in the Appendix.

See the Appendix for further information on the appropriate use of the formula and the assumtpions inherent in its use.

The expected increase would be from $16.72 to $18.33. (2) The upward shift in market price would reduce the quantity of the commodity demanded by 1.1 percent. 47/ The average annual quantity of the commodity demanded would fall from 5251 thousand cwt. (11) to 5,193 thousand cwt (2).

The gross receipts of all U.S. growers of this commodity would increase because the elasticity of demand is below -1.0 in value. The initial average annual quantity, when priced at $16.72 per cwt. would generate gross receipts of $87,796.7 thousand. After adjustment to the new market price, the gross receipts accruing to all U.S. growers would be approximately $95,187.7 thousand. The gain for all U.S. growers would be approximately $7,391.0 thousand.

The change in gross receipts for Florida growers would make up a major proportion of the gross increase for the U.S. as a whole. The assumption is made that the price of green peppers grown in Florida will increase by the same percentage as that of the U.S. as a whole. Over the period 1975-77, the average annual price of Florida green peppers was $21.38. An increase of 9.6 percent would increment this price to $23.43. This price would be multiplied by the production in Florida after account is taken of the yield reductions imposed by the cancellation. The initial yield in Florida is approximately 101.4 cwt per acre. A 19 percent reduction in yield would imply a yield per acre of 82.13 cwt. per acre on the affected acreage in Florida. The total revenue per acre on this acreage would fall from $2,168 to $2,376 (Table II-37b). This increase of $208 per acre represents the windfall gain on the 5,756 acres on which EBDC's are not used. Thus, for the entire State the windfall increase in gross receipts on this acreage would be $1,197,248.

On the acreage directly affected by the cancellation, the loss per acre is

47/ This percentage is obtained by multiplying the percentage increase in market equilbrium price, 9.6, by the elasticity of demand, -0.111.

approximately $244. The estimated average annual acres treated with EBDC's in Florida is approximately 12,811. For the State as a whole, the total loss in gross receipts on this acreage is $3,125,884. Thus, for the entire State the net loss in gross receipts on green pepper production would be $1,928,636.

With the information developed above, an estimate of the net change in gross receipts for all U.S. pepper growers can be made. For the U.S., the increase in gross receipts accruing to all green pepper growers would be $7,391,000. The losses in gross income incurred on the affected Florida acreage would be approximately $3,125,884. Thus, the net change in gross income on all U.S. green pepper production is approximately $4,265,116.

Impact on Net Returns

The net returns accruing to farmers growing green peppers would be affected by the change in the market price of the commodity, the change in yield per acre and the change in the cost of production. As noted above, the increase in price would have the effect of increasing the net returns of growers not using the EBDC fungicide. Decreases in yield and increases in cost would reduce the net returns of the users of the fungicide. As assessment of the impact on net returns in certain parts of Florida can be discerned by looking at Tables II-38 and II-39. Table II-38 shows the cost, revenue, and yield information for the Immokalee-Lee area in Florida. The net return per acre for the period 1976-77 was $239.76. A 9.6 percent increase in price, a 19 percent reduction in yield, and a $35.87 cost increase per acre would result in a loss per acre of $176.12. This loss would result from the fact that yield

per acre in this area would fall from 548 bushels per acre to 444 bushels per acre. Total production cost would increase form $3,168.33 to $3,204.20. Also, the price per bushel would be expected to increase from $6.22 to approximately $6.82.

If a loss per acre of $176.12 were incurred by growers in this are a, (Immokalee-Lee), it is likely that there would be some shifts to other crops grown in that part of Florida. The other crops grown in the Immokalee-Lee area are tomatoes, cucumbers, squah, Irish potatoes, ane watermelons. (7) If the use of the EBDC fungicide were suspended only on green peppers, it is likjely that the reductiond in net returns would induce some acreage shifts to those crops. However, these crops may all be directly affected by an EBDC cancellation. It is not possible to estimate accurately the direction and extent of acreage shifts to other crops.

Table II-39 shows per acre costs, yield, and returns for a part of Florida called the Palm Beach-Broward area. The data shown apply to the 1976-77 period. The net return per acre is $277.37. The same percentage price increases, percentage yield reductions and cost increases as those mentioned above, would reduce the net return in this area to a negative number. The resulting net loss per acre would be $140.76. Such a net loss would probably induce shifts to alternative crops grown in this area. The other major crops grown in this part of Florida are snap beans, eggplant, cucumbers, sqaush and tomatoes. (7) Again, since most of these alternative crops would be affected by an EBDC

cancellation no precise estimate can be made concerning the extent of direction of the acreage shift.

Consumer Impact

Changes in the Quantity and Quality Available

The initial impact of a cancellation on the EBDC fungicides would be a reduction in the quantity of the commodity available. The average annual quantity marketed would be expected to fall from 5,251 thousand cwt to 5,004 thousand cwt. However, this reduction does not take account of the adjustment to the increased price that would occur after the initial reduction in supply. The adjustment to increase the quantity of green peppers marketed from 5,004 thousand cwt. to an estimated 5,193 thousand cwt. per annum. This latter amount, when measured against initial average annual production, would represent a reduction in the quantity marketed of approximately 5.8 million lbs. This reduction would represent a 1.1 percent reduction in the quantity of the commodity available to consumers.

Change in Consumer Expenditure

The increase in the price of green peppers at the farm level would be passed on, in part, as increased prices at the retail level. The increase in price at the retail level would mean an increase in total expenditures by U.S. consumers for this commodity. This increase in total expenditure occurs mainly because consumers of this commodity are relatively unresponsive to price changes in terms of quantities consumed.

It is estimated that the growers share of the retail price of

green peppers is approximately 42 percent. 48/ The average annual price a the farm level over the period 1975-77 was $16.72 per cwt. If this amount represents 42 percent of the retail price, the retail price would be estimated to be approximately $39.81 per cwt. At this price, the total expected to be approximately $209.0 million. 49/

It is estimated that the 9.6 percent increase in price at the farm level will be accompanied by a 6.6 percent increase in price at the retail level. 50/ A 6.6 percent increase in price at the retail level would mean an increase from $39.81 to $42.44 per cwt. At the total expenditure made by U.S. consumers would thus be about $220.4 million. 51/ The estimated additional outlay made by consumers would be approximately $11.4 million as a result of a cancellation on the use of EBDC fungicides on this commodity.

48/ This estimate was obtained from Mr. Stephen M. Raleigh of the Commodity Economics Division of ESCS, U.S. Department of Agriulture. This percentage was that which held for the year 1977.

49/ This estimate is based on the assumption that the quantity marketed per annum is approximately 5,251 thousand cwt. The exact estimate is $209,042,310.

50/ This estimate assumes an elasticity of price transmission equal to 0.69. The elasticity of price transmission is a ratio of percentages in which the percentage change in price at the farm level is in the denomenator and the percentage change in the retail price is in the numerator. The elasticity of transmission, 0.69, is found in P.S. George and G.A. King, Consumer Demand for Food Commodities in the United States With Projections for 1980, Giannini Foundation Monograph Number 26, March 1971. The elasticity is estimated for a group of commodities titled "other fresh market vegetables".

51/ The exact estimated value would be $220,390,920.

Summary of Impact

For the State of Florida, the windfall gain which would accrue to growers not using the EBDC fungicides on this commodity would be approximately $1.2 million in gross receipts. The growers directly affected by the cancellation would incur a windfall loss in gross receipts of approximately $3.1 million. The net reduction in gross receipts would be approximately $1.9 million for the entire State.

Growers of this crop outside the State of Florida would not be directly affected by the cancellation on the EBDC fungicides. However, they would be indirectly affected by the increase in the price of the commodity. Growers in other States would incur a gain in gross receipts of approximately $5.5 million. The net gain in gross receipts for all U.S. growers of green peppers (inclusive of Florida growers) would be approximately $7.4 million.

Table II-36. Acreage and Production Affected - Green Peppers

State	Average acres planted 1975 1977 1/	Percent acres treated - EBDC 1976 2/	Expected annual acres treated with EBDC	Average annual production 1975-1977 (100 CWT) 3/	Percent of average U.S. production 1975-1977 4/	Percent of U.S. production treated in states
Florida	18,567	69	12,811	1,883	35.9	24.8

1/ Vegetables, 1977 Annual Summary Acreage, Yield, Production and Value, Crop Reporting Board, Statistical Reporting Service, U.S. Department of Agriculture, Dec. 23, 1977

2/ Assessment of EBDC Fungicide Uses in Agriculture Part II. An Analysis of Current EBDC Uses; Their Benefit, the Role of Alternatives, and Impacts to Agriculture From Changes in EBDC Use Patterns. USDA/State/EPA Assessment Team Coordinated by the Office of Environmental Quality Activities, USDA, April, 1978.

3/ Vegetables 1977 cited above

4/ Ibid.

Table II-37aTreatment Cost Per Acre and Total- Green Peppers

State	Average number of EBDC applications per acre 1/	Pounds active ingredient applied per application 2/	Estimated EBDC A.I. per acre per season	Estimated materials cost per acre with EBDC 3/	Estimated quantity of preferred alternative used per acre per A.I. 4/	Estimated cost per acre with the preferred alternative 5/	Estimated increase in cost per acre with the alternative	Total Material cost impact for State 6/ (1000 dollars)
Florida	7.6	1.2	9.12	17.33	30.4	53.20	35.87	495.5

1/ Source: Assessment of EBDC Fungicide Uses In Agriculture Part II. An Analysis of Current EBDC Uses; Their Benefit, The Role of Alternatives, and Impacts to Agriculture From Changes in EBDC Use Patterns. USDA/State/EPA Assessment Team, Coordinated by the Office of Environmental Quality Activities, USDA, April

2/ Ibid. "The specific EBDC fungicides used are maneb and zeneb.

3/ The estimated cost per Lb. for the EBDC fungicide is $1.90. This cost estimate is an average derived from several recent price lists/

4/ Copper: Source, Assessment of EBDC Fungicide Uses in Agriculture

5/ The price per pound of active ingredient for the alternative, copper is $1.75. This price is an average derived from several recent price lists.

6/ This estimate is the arithmetic product of the acres treated (Table II-36) and estimated increase in cost per acre with alternative.

Table II-37b. Impacts on production cost and production - green peppers

State	Proportion of U.S. production treated in the State 1/	Average revenue per acre 1975-77 (Est. average cost) 2/	Increase in material cost with alternative fungicide 3/	Estimated percent change in cost per acre	Estimated weighted percent impact on U.S. average production cost 4/	Estimated expected percent yield loss per acre in the State 5/	Estimated weighted percent reduction in U.S. supply 6/
Florida	0.248	$2,168	$35.87	1.7	0.42	19.0	4.7

1/ Source: Vegetable 1977 Annual Summary, Crop Reporting Board, USDA. The proportion is obtained by dividing the percentage in the rightmost column of Table II-36 by 100.

2/ Source: Ibid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rational for this assumption is outlined in the Appendix.

3/ Source: See Table II-37a.

4/ The item in the column represents the percentage impact on U.S. production cost originating in the State.

5/ Assessment of EBDC Fungicide Uses in Apriculture, Part II, USDA/State/EPA Assessment Team, April 1978.

6/ The percentage is the yield loss in Florida weighted by the percent of U.S. production treated in the State.

Table II-38. Peppers: Costs and returns in the Immokalee-Lee area

Item		1976-77	
Number of growers		9	
Number of acres		2196	
Average acres per grower		244	
Average yield per acre (bushels)		548	
Growing costs:		Average per	
		Acre	Bushel
Land rent		$ 34.37	
Seed		118.53	
Fertilizer		290.61	
Spray and dust		278.90	
Cultural labor		477.45	
Machine hire		31.07[a]	
Gas, oil and grease		92.03	
Repair and maintenance		172.22	
Depreciation		92.82	
Licenses and insurance		65.28	
Interest on production capital (9% - 5 months)		64.04	
Interest on capital invested (other than land)		13.92	
Miscellaneous expense		147.18	
Total growing cost		1878.52	$ 3.428
Harvesting and marketing costs:			
Picking expense		362.71	.662
Grading and packing expense		432.15	.789
Containers		278.00	.507
Hauling		108.83	.199
Selling		108.12	.197
Total harvesting and marketing cost		1289.81	2.354
Total crop cost		3168.33	5.782
Crop sales		3408.09	6.219
Net return		$239.76	$ .437

Source: D. L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 with Comparisons, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, March 1978.

Table II-39. Peppers: Costs and returns in the Palm Beach-Broward area

Item	1976-77	
Number of growers	7	
Number of acres	1100	
Average acres per grower	157	
Average yield per acre (bushels)	689	
Growing costs:	Average per	
	Acre	Bushel
Land rent	$ 56.92	
Seed	88.48	
Fertilizer	204.48	
Spray and dust	242.54	
Cultural labor	692.95	
Machine hire	158.67	
Gas, oil and grease	99.81	
Repair and maintenance	106.21	
Depreciation	88.20	
Licenses and insurance	89.96	
Interest on production capital (9% - 5 months)	72.40	
Interest on capital invested (other than land)	13.23	
Miscellaneous expense	210.75	
Total growing cost	2104.60	$ 3.055
Harvesting and marketing costs:		
Picking and packing expense	449.82	.653
Containers	328.65	.477
Hauling	107.62	.156
Selling	144.14	.209
Total harvesting and marketing cost	1030.23	1.495
Total crop cost	3134.83	4.550
Crop sales	3412.20	4.952
Net return	$277.37	$ .402

Source: D. L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 with Comparisons, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, March 1978.

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING EBDC USE ON LETTUCE

A. USE: EBDC use on commercial lettuce production

B. MAJOR DISEASES CONTROLLED: Downy mildew

C. ALTERNATIVES:

Major registered chemicals: Captan, Copper, Folpet

State recommendations:

Number of States Recommending for Downy Mildew	
EBDC	22
Captan	1
Copper	3
Folpet	3
No alternatives recommended	16

Non-chemical controls: Effective non-chemical control methods are not available.

Efficacy of alternatives: Copper is an effective alternative to EBDC for downy mildew control in Arizona and California. Captan and Folpet do not provide control necessary for commercial lettuce production.

Comparative performance: Copper fungicides cause yellowing of wrapper leaves and light brown necrotic areas on leaf and leaf blades. This phytotoxicity would result in an estimated 12.5% marketable yield reduction and a quality reduction on the remaining marketable portion from the treated acreage.

Comparative costs: The difference in material cost per acre per season would be $1.15 in California and Arizona. Florida growers would cease lettuce production if EBDC's were not available.

D. EXTENT OF USE:

Active ingredient basis: Annually, 260,000 pounds (a.i.) of EBDC's are applied to lettuce in California (156,000 lbs), Arizona (76,000 lbs), and Florida (28,000 lbs.).

Alternatives are currently seldom used.

Acres treated basis: Annually 67,900 acres of lettuce are treated with EBDC's in California (39,000 acres), Arizona (19,000 acres), and Florida (9,900 acres). Proportionally, the percentage of acres grown receiving treatment is 25%, 50%, and 100% in California, Arizona, and Florida, respectively. In terms of percent of U.S. lettuce production treated in state, it is estimated to be 18.4%, 7.3%, and 2.6% in the three states, respectively.

E. ECONOMIC IMPACTS:

User: Users in California and Arizona would suffer an average yield reduction of 12.5% plus quality reduction on the remaining production. Florida growers are expected to cease commercial lettuce production. After price adjustments, revenue on affected acres would decline by $10.7 million ($273/acre) and $4.2 million ($221/acre) in California and Arizona, respectively. Florida growers would shift from lettuce, losing $16.4 million in gross revenue, to sweet corn with a gross revenue of $8.2 million giving a net loss in revenue of $8.2 million. The effect on net revenue is not known.

Market/Consumer: Lettuce production would be greatly reduced in Florida. Although California and Arizona growers would face yield losses, planted acreage would likely increase in these states in response to higher prices so that total production would decline by less than 1%. There would be a quality loss on about one-fourth of lettuce produced. Retail prices could increase by about 10% on average or about $123 million in total.

Macroeconomic: No major impacts

F. SOCIAL/COMMUNITY IMPACTS: Not investigated.

G. LIMITATIONS OF ANALYSIS:

1. Usage estimates are from assessment team members and not grower surveys.
2. Market impacts are estimated using elasticities which may not be precise for the impacts expected on productions.

H. PRINCIPAL ANALYSTS AND DATE:

John Bratland, USDA
Gary Ballard, EPA
December, 1978

Lettuce

User Impact

The need for effective fungicides on lettuce stems primarily from the damage caused by one disease, downy mildew (Bremia Lactucae). It effects lettuce in these 3 States—California, Arizona, and Florida. This particular disease poses the most acute problem in Florida. The high humidity in the Florida growing areas create an environment that is conducive to the development and spread of this disease requiring 100 percent of the acreage to be treated (1). Fortunately, Florida accounts for only 3 percent of the U.S. production compared to California's 74 percent and Arizona's 15 percent (Table II-40).

Alternative Control Programs

The alternative fungicides registered for use on lettuce are not as effective as the EBDC fungicides. Copper is the one most likely to replace the EBDC's. Though this fungicide was used before the EBDC's were introduced, it does not represent a totally satisfactory alternative today. This fungicide is effective in controlling downy mildew, but it damages the lettuce in a manner that results in a reduction in quality and therefore grade and price (1). The economic implications of this reduction in quality will be explored below.

Impact on Production Cost

The impact on an EBDC cancellation would add very little to outlay per acre for fungicides. In California and Arizona, the EBDC fungicides are applied at a rate of 4.0 lbs. per acre per growing season. The outlay per

acre for EBDC fungicides in these States would be $7.60 (Table II-41a). The copper base fungicides sell for approximately $1.75 per pound of active ingredients and are applied at a rate of 5.0 pounds per acre per season for a cost of $8.75 per acre. For these States, disease control costs would increase $1.15 per acre if the EBDC's are cancelled.

In Florida, EBDC fungicides are applied at a rate of 2.8 pounds a.i. per acre per season for a cost of $5.32 per acre (Table II-41a). If the EBDC fungicides were withdrawn, this amount would represent the saving in material cost because the alternative material, copper, would not be used.

For California and Arizona, it was assumed that all of the acreage currently treated with EBDC's would be treated with copper (5).

These changes in cost per acre would be relatively insignificant in the 3 selected States. However, the major importance of an EBDC cancellation lies not in production cost changes that would be incurred, but rather in yield reductions and reductions in grade and quality.

<u>Dollar Losses per Acre from Changes in Grade and Quality</u>

An EBDC cancellation would have a major impact on yield levels and on the grade and quality of the marketed crop. In California and Arizona, it was estimated that yields would be reduced 12.5 percent if copper replaced the EBDC fungicides. In Florida, there are no alternative fungicides to replace the EBDC fungicides if they are cancelled and yields are estimated to be reduced 20 percent.

At current prices, these yield reductions would result in losses per acre of $235.25 and $211.75 in California and Arizona, respectively (Table II41a). Once account is taken of price changes, these estimated

losses per acre will differ significantly from those shown in Table II-41a.

The per acre losses for California and Arizona would be $205.85 and $185.25, respectively. These estimates are based on the assumptions that a 45 pound carton of lettuce treated with the copper fungicides would sell for approximately 12.5 percent less than that treated with the EBDC's (Table II-41b). This reduction in price would occur because copper has the effect of turning some of the lettuce leaves yellow.

In Florida, grade and quality reductions of $329.60 would occur because of the effect of downy mildew (Table II-41a). This estimate is based on the assumption that untreated lettuce would sell in the Florida lettuce market at a price 25 pecent below that of lettuce currently treated with the EBDC fungicides (Table II-41b).

Changes in Production and Estimated Acreage Shifts to Other Commodities

As mentioned earlier, losses would occur on both acreage treated with copper and acreage not treated with the alternative fungicide. It is estimated that total impact, fungicide cost, and yield loss in Florida would be $659.20 per acre, or 40 percent of the 1975-77 average annual revenue. Production cost budgets are not available for lettuce in Florida. However, growers would not continue to grow lettuce in this State. Thus, the 2.6 percent of U.S. lettuce accounted for by the State would represent the reduction in supply that would result from an EBDC fungicide cancellation.

In California and Arizona, total revenue would be reduced 23.5 percent per acre. This loss does not take into account a change in price. Apparently, these losses would not be great enough to induce growers to shift into alternative crops. The variance in lettuce prices is great enough to encourage

a certain degree of "risk taking" behavior on the part of growers. Losses could thus be incurred for several seasons in these States without sufficient acreage shifts to alternative crops (5).

The average annual level of lettuce production for the period 1975-77 was about 54.3 million cwt. The output losses in each of the three States would result in a 5.8 percent fall-off in this average annual production level (Table II-41b). This loss would be slightly over 3.2 million cwt. as a result of a cancellation on the use of EBDC fungicides on lettuce. The loss in production estimated above does not take account of changes in quantities marketed that would occur as a result of price increases.

Change in Commodity Price and Farm Income

The estimate of change in price will take account of the reduction in U.S. output and the reduction in price for lettuce sold at a reduced price because of quality reduction. The former effect of the EBDC cancellation will be treated as a reduction in supply in the sense that less lettuce will be marketed for each and every price. The latter effort will be treated as a reduction in demand faced by the grower in the sense that he will be paid less for each and every amount marketed.

The concepts of demand and supply elasticity will be used in making estimates of price changes that would result from a cancellation of EBDC use. The price elasticity of demand for lettuce is estimated to be -0.048 (3). The elasticity of supply for lettuce is estimated to be .337 (4). The loss in lettuce production for the total U.S. would be about 5.8 percent (Table II-41b).

The lettuce marketed at a reduced price because of quality reductions would have an effect on the average U.S. farm level price of the commodity. An average of 12.5 percent price reduction will be assumed with the average price for 1975-77 used as a base. 52/ This reduction would be a percentage change of 12.5 percent for both California and Arizona (Table II-41b). Each of these percentage reductions in price must be weighted by the proportion of the total U.S. lettuce production grown in the State. For California, the proportion is 0.184, and for Arizona the proportion is 0.073 (Table II-41b). The sum of these weighted percentages would equal 3.2 percent. Thus, the average price reduction for the U.S. as a whole would be 3.2 percent. A reduction in total U.S. output of 5.8 percent and a reduction in average U.S. marketed price of 3.2 percent would induce a net price increase of 14.7 percent. 53/

52/ Dr. Albert Paulus of the EBDC Assessment Team has made an effort to determine the extent of this reduction in price. He has determined that the reduction would average 12.5 percent on crates of lettuce being sold at a price of approximately $4.00.

53/ This estimate was derived through the use of the following formula:

$$\% \text{ change in price} = \frac{5.8}{0.377 + 0.048} - \frac{3.2}{\frac{0.377}{0.048} + 1} = 14.67$$

14.67 = net percentage price change at farm level for the total U.S. lettuce market
5.8 = the reduction in total lettuce output for the U.S. as a whole
3.2 = the average weighted percentage price reduction for the U.S. incurred because of quality changes
0.337 = the price elasticity of supply for lettuce
0.048 = the price elasticity of demand for lettuce

The formula is an algebraic sum of two formulas developed in the Appendix. See the Appendix for further information on the appropriate use of these formulas and the assumptions inherent in their use.

The average annual price per cwt. of lettuce over the period 1975-77 was \$7.81. Based on an annual quantity marketed of 54.3 million cwt., the total revenue to lettuce growers is \$424 million.

An increase of 14.7 percent in the price of lettuce for the U.S. as a whole would put the value per cwt. at approximately \$8.96. Once growers have adjusted to such a price increase, the total quantity of lettuce marketed would not have been reduced by 5.8 percent, but rather by 0.71 percent. With the reduced quantity marketed at a price of \$8.96, the estimated increase in total revenue would be over \$59.0 million for all lettuce growers in the U.S.

There would be differential impacts for the areas that would be directly affected by a cancellation. The extent of the impact on lettuce growers in Florida would be difficult to assess since the assumption was made that they would stop producing lettuce if the EBDC's were cancelled. It is assumed that Florida growers would choose the most profitable alternative crop.

With respect to California and Arizona, it was assumed that the average annual price of lettuce at the farm level would increase by 14.7 percent, the same as the U.S. price. The average annual price for lettuce in California during 1975-77 was \$7.37 per cwt. With a yield per acre of 256 cwt. the average revenue per acre for the period 1975-77 was \$1,886 (Table II-41a). A 14.7 percent increase in price would put the price at \$8.45 per cwt. This would be the price of lettuce unaffected by the quality reduction imposed by a cancellation on the use of EBDC fungicides. With a yield per acre of 256 cwt., the total revenue generated per acre on this lettuce acreage not affected by the cancellation would be \$2,163.

After an EBDC cancellation, the yield per acre on the affected acreage would be about 224 cwt. This acreage would also yield a reduced quantity of

lettuce that would sell at a lower price. The price of lettuce sold at a reduced quality or grade was estimated $7.40 per cwt. The total revenue generated per acre on this acreage would be $1,648 per year. There would thus be a gain in total revenue of $277 per acre on the acreage not directly affected by a cancellation and loss in total revenue per acre of $230 on the acreage directly affected by a cancellation of the use of the EBDC fungicides (Table II-41a).

The estimate of the total dollar impact on the State at the farm level would take into account the adjustment in acreage. A downward adjustment in acreage would be expected to accompany the decline in the total quantity marketed. It is estimated that there will be a 0.71 percent reduction in the quantity of lettuce marketed in the U.S. once adjustment to price is taken into account. It is estimated that 1,110 of the adversely affected acres would shift to alternative crops in California. This number would be subtracted from 39,092 (Table II-40), the acres currently treated with EBDC's in California. This acreage would be treated with the copper fungicide if the EBDC fungicides were cancelled. The following listing shows the acreage, revenue per acre, and total revenue generated on both the affected and unaffected acreage. 54/

	Total acres	Revenue per acre	Total revenue generated
Affected	37,982	$1,648	$63.0 million
Unaffected	117,284	$2,163	$253.7 million
Total	155,110		$316.7 million

54/ The affected acreage is that on which the EBDC fungicides are used currently. The numbers included in the listing are those that would hold once allowance is made for changes in price, quantity marketed, and acreage changes.

The current estimated annual revenue generated is $294.9 million. Thus, the total gain to growers in the State would be $21.8 million. However, a certain proportion of the growers would be adversely affected. The total revenue on the adversely affected lettuce acreage would fall from about $73.7 million to $62.0 million.

In Arizona, 50 percent of the lettuce acreage is currently treated with the EBDC fungicides. In Arizona, the average revenue per acre per year for the period 1975-77 was $1,695.00 based on a yield per acre of 209 cwt. and a price of $8.11 per cwt. (Table II-41a).

The assumption is made that, in the event of an EBDC cancellation, the price of lettuce in Arizona would increase 14.7 percent, the same as for the U.S. Such an increase would result in a lettuce price of $9.30 per cwt. Based on a yield of 209 cwt. per acre on the unaffected acres, the total revenue per acre would be $1,944.

On the affected acreage the yield would fall from 209 cwt. to 183 cwt. per acre. The lettuce grown on this acreage would sell at a reduced grade and a lower price. Thus, the lettuce of reduced quality would sell for about $8.14. Consequently, the revenue per acre on the acreage affectd by an EBDC cancellation would be $1,490 per year.

On the acreage on which the EBDC fungicides are not used, the gain in total revenue per acre in Arizona is $249 and on the affected acreage the reduction in total revenue per acre would be $205.

The total dollar impact at the farm level for Arizona is estimated by taking into account the adjustment in acreage. The adjustment in acreage is estimated in the same manner as for California. The estimated percentage

reduction in quantity marketed for the U.S. of 0.71 percent will be used to estimate the percentage reduction in lettuce acreage in Arizona. This would reduce Arizona acreage from 28,067 to 37,397 (Table II-40). The estimated 270 is subtracted from the 19,033 acres treated with EBDC's in Arizona and would be treated with the copper fungicides if the EBDC fungicides were cancelled (Table II-40). The following listing shows the estimated average revenue per acre and total revenue generated at the farm level on both the affected and unaffected acreage in Arizona. 55/

	Total acres	Revenue per acre	Total revenue generated
Affected	18,763	$1,490	$28.0 million
Unaffected	19,034	$1,944	$37.0 million
Total	37,758		$65.0 million

After an EBDC cancellation, it is estimated that lettuce revenue would be $65.0 million compared to the current revenue of $64.5 million or a gain of $0.5 million.

There would be a redistribution of income within the State. The income on the affected acreage would fall from $32.2 million to $28.0 million. The income generated on the acreage on which the EBDC fungicides are not used would increase from $32.2 million to $37.0 million.

Impact on Net Returns and Shifts to Other Crops

Problems arise in attempts to assess the impact on net returns per acre of an EBDC cancellation on lettuce. The most common difficulties would

55/ The affected acreage is that on which the EBDC fungicides were used currently.

include the following:

(1) Budgets apply to production in a relatively small area or region within a State;

(2) Budgets are usually not available for a major part of a State engaged in the production of a particular crop; and

(3) Production budgets usually do not show cost levels for various levels of output or yield.

Each of these difficulties can impose severe constraints in assessing the impact on net returns of a particular pesticide cancellation. In the case of lettuce, all of the above considerations imposed problems. Since there would be significant yield reductions in two of the affected States, the problem mentioned in the third point restricts the range of budget information that could be used.

Table II-42 shows budget information for an area in California. The quantities in this budget have been converted from 47 lb. cartons to cwt. The two components that vary with production level are the harvest cost at $3.83 per cwt. and management cost based on 5 percent of gross receipts.

In Table II-42, the two rightmost columns show the production cost that would correspond to two different yield levels in California. The average lettuce yield on California acreage for the period 1975-77 is 256 cwt.

After an EBDC cancellation, the average yield on the affected acreage in California would fall to an estimated 224 cwt. per acre with an estimated total cost per acre of $1,622.49. The management cost has not been changed because the opportunity cost of the management resource will not have changed even though yield on the acreage will have fallen by 12.5 percent. The estimated total revenue on this acreage would be $1,658 resulting in a net return per acre of $35.51. Since returns to management are already accounted

for, the net return, $35.71, is adequate "profit" to prevent a significant acreage shift to other crops.

There would be significantly greater net returns to growers in California not directly affected by the need to use an alternative fungicide. The gross revenue per acre on this acreage would be $2,613 as a result of the increase in lettuce prices. The estimated production cost per acre would remain at $1,745.05 with a net return of $417.95 per acre. The increase in net return on this acreage would be $277.

The leftmost columns in Table II-42 show production costs for two yield levels in Arizona. The yield of 209 is the average for all acreage in Arizona for the years 1975-77. The estimate of 183 cwt. reflects the 12.5 percent reduction in yield that would occur if the EBDC fungicides were cancelled. The average annual revenue per acre in Arizona over the period 1975-77 was $1,695 per acre (Table II-41a). With production costs at $1,555.49, per acre net return per acre prior to an EBDC cancellation in Arizona would be $139.51.

If a cancellation were imposed on the use of EBDC fungicides on lettuce, the average yield per acre would fall to 183 cwt. per acre with revenue at $1,490. The production cost would fall to $1,455.91 resulting in a net return of $34.09 per acre. This estimated net return per acre would apply to roughly 50 percent of total lettuce acreage in Arizona if the EBDC's were cancelled.

The yield level per acre would not be reduced on the acreage in Arizona not directly affected by a cancellation of the EBDC fungicides. Once price increases are taken into account, the revenue per acre on this acreage would be $1,994. With production cost at $1,555.49 per acre per season, the net return would be $388.51. This net return would represent an increase of $249 over the net return that would be realized prior to the cancellation of the EBDC

fungicide.

In Florida, the economic consequence of the shift to other crops is more difficult to assess. 56/ As noted above, an EBDC cancellation would induce losses per acre of sufficient magnitude to force lettuce growers in Florida into alternative crops. 57/ The assumption is made that virtually all of the 9,933 acres (Table II-40) grown in Florida would shift to other crops. 58/ The selection of alternative crops would apparently not be done solely on the basis of current profitability. 59/ Though sweet corn is not a particularly profitable crop in Florida, it would be the crop toward which lettuce growers might shift if the EBDC fungicides were banned (9). Most of the lettuce in Florida is grown in the Everglade region. Sweet corn production would thus expand in the Everglade area of Florida if the EBDC fungicides were cancelled from use on lettuce.

An estimate of the average annual revenue per acre for sweet corn in the Everglades is based on the estimated yields per acre and upon the adjusted

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56/ According to Dr. D. L. Brooke, no production budgets have been prepared for lettuce production in the State of Florida.

57/ The assumption is made that this shift to alternative crops would occur rather rapidly. In reality, several years may elapse before lettuce production in Florida ceases.

58/ This assumption is supported by the expert judgement of Dr. Robert McMillian, Plant Pathologist, University of Florida, Gainesville. Dr. McMillian is an expert on vegetable crops and is a member of the EBDC Assessment Team.

59/ Dr. D. L. Brook points out that celery is quite profitable currently. However, it probably would not be chosen by lettuce growers as an alternative crop. Its production is controlled on the basis of acreage allotments. Controlled production would impede the choice of celery as an alternative to letttuce

the EBDC fungicides would increase the per acre production costs of sweet corn in Florida by $24.65. This increase in cost would reduce the expected net return in the Everglade area to $124.79.

If all 9,933 acres of lettuce were to switch to sweet corn, production of this commodity would increase by 1.0 million cwt. in Florida. This estimate is based on the assumption that the yield per acre of sweet corn acreage in the Everglades formerly in lettuce production will sustain the same yield levels as that already in sweet corn production. This estimated yield level is 102 cwt. per acre. This increased production would represent an 18.4 percent increase in the average annual adjusted production for Florida and a 7.1 percent increase in production for the U.S. as a whole. This increase in U.S. production will force the price of sweet corn downward. However, this increase in production will be only one of two factors which will affect the price of sweet corn after a cancellation of the EBDC for use on each of these crops.

The other factor will be the additional cost incurred in using a more expensive fungicide. In this case the fungicide is chlorothalonil and, as noted above, the use of this alternative material would increase production costs by $24.65. This increase in cost would be an average weighted percentage increase in production cost of 1.2 percent for the U.S. 63/ The combined effect of the increase in production and the increase in production cost would be a downward adjustment in the average U.S. price of 10.7 percent. The assumption is made that the average annual Florida price would fall by

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63/ This percentage is derived by noting that $24.65 is 4.0 percent of $772.64 and that the treated acreage in Florida accounts for 37.6 percent of U.S. production of sweet corn.

the same percentage. 64/ As indicatd above, the average annual adjusted price of sweet corn in Florida was $9.04 for the period 1975-77. A 10.7 percent reduction would result in a price of $8.07 per cwt. With an average yield of 102 cwt. per acre in the Everglades, growers switching from lettuce to sweet corn would obtain a gross revenue per acre of $823.14 on the latter crop. Thus, after the downward price adjustment, the net return per acre on sweet corn would be reduced from $124.79 to $25.85.

Though no estimate can be made of the loss in net revenue to Florida lettuce growers, an estimate of the change in gross receipts is possible. Table II-41a shows that the average annaul gross revenue per acre on Florida lettuce was $1,648.00 for the years 1975-77. After the shift of the acreage

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64/ This estimate would be obtained through the use of the following formula:

$$\%\ \text{change in price} = \frac{(0.4)(1.2) - (7.1)}{(0.22 + 0.4)} = -10.7$$

The following definitions apply to the above formula:

% P = the percent change in average market price

(0.4) = the elasticity of supply that will be used in this assessment. This elasticity applies to a larger group of commodities classified as "vegetables" (12)

(1.2) = the estimated weighted percentage increase in production cost per cwt. for the entire U.S.

(0.22) = the elasticity of demand that will be used in this assessment (11). This elasticity is an arithmetic product of the retail price elasticity of demand, -0.32, and the average elasticity of price transmission for 5 fresh market vegetables. The average elasticity of price transmission for these vegetables is about 0.69.

(7.1) = the percent increase in the supply of sweet corn

The formula used above is an algebraic sum of two formulas developed in the Appendix. See the Appendix to the vegetable section for more information on the appropriate use of the formulas and the assumptions inherent in their use.

into sweet corn production, the expected gross revenue per acre would be $823.14. Thus, the loss in gross revenue would be about $825 per acre. On all of the 9,933 affected acres of lettuce in Florida, the total estimated loss would be $8.2 million.

Summary of Impact on Gross Income at the Farm Level

As noted earlier, the 14.7 percent increase in the price of lettuce would mean a net increase of $59.0 million in gross receipts for U.S. lettuce growers. However, the loss incurred by Florida lettuce growers in switching to corn must be subtracted from this figure. This loss was about $8.2 million. Thus, the net gain in gross revenue for the total U.S. is $50.8 million.

Consumer Impact

Changes in Quantity and Quality of the Product Available

There would be both a reduction in the quantity and quality of lettuce available to consumers if the EBDC fungicides were cancelled. In terms of quantity available to consumers, there would be an expected immediate reduction of 5.8 percent in total output. This reduction would have two components:

(1) the loss of all lettuce production in Florida (2.6 percent of the U.S. total); and

(2) the loss in output in California and Arizona because of yield reductions.

This reduction in output would not take account of the adjustment in price and the subsequent adjustment in output to the price increase. As

shown above, the estimated annual U.S. output would be 54.3 million cwt. after an adjustment to the price increase. This output level would represent a reduction of 0.71 percent of the average annual output level for the period 1975-77.

The reduction in quality of lettuce marketed would apply to the part of the crop produced in California and Arizona. Of the new equilibrium output level, 18.9 percent would be copper treated lettuce from California. 65/ Also, 7.3 percent of the new equilibrium output for the U.S. would be copper treated lettuce from the affected acreage in Arizona. This output would total to 26.2 percent of the U.S. total output after price adjustment. This number would represent the percentage of total lettuce output consumed that would be of a reduced grade or quality level.

Changes in Consumer Expenditures

The average annual price of lettuce per cwt. over the period 1975-77 was $7.81. It is estimated that the price paid to growers is 33.9 percent of the retail price of lettuce (11). Thus, the estimated average annual price of lettuce at the retail level was $23.04 per cwt. 66/ The elasticity of price transmission is estimated to be 0.676 for lettuce. 67/ The implication of

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65/ The percentage would take account of the yield reduction on the affected acreage in California.

66/ Since this price is a three-year average for 1975-77, it is necessarily below the very high prices that existed in early 1978.

67/ The elasticity of price transmission is the ratio of the relative change in retail price to the relative change in the farm level price.

average annual price received by sweet corn growers in Florida. 60/ The weighted average yield obtained in the Everglades was 203 crates per acre during the period 1975-77. 61/ The average weight of a crate of sweet corn in Florida is 50 lbs. (10). Thus, the average yield per acre is 102 cwt. At the average annual adjusted price of $9.04 per cwt., the estimated revenue per acre is $922.08 (10). The weighted average cost per acre for the Everglade area is $722.64. 62/ Thus, the estimated average annual net return per acre in this area was $149.44 for the period 1975-77. This is the estimated net return per acre on sweet corn in Everglades prior to the imposition of an EBDC cancellation. As noted in the section on sweet corn, a cancellation of

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60/ The yield information for this part of Florida is derived from Costs and Returns from Vegetable Crops in Florida. An average is obtained which is weighted by the number of acres allocated to sweet corn in the area in each of the respective years 1975 through 1977.

The price obtained by growers in the Everglades is assumed to be the adjusted average annual price for the State as a whole. The adjustment made was necessary to account for the frost that occurred in the winter of 1977. This frost destroyed most of the Florida winter crop of that year. The adjustment was accomplished by assuming that the yields and prices obtained for the winter crop in 1977 were the same as those obtained for the winter crop in 1976. This assumption was applied to all 12,500 acres planted in the State for the 1977 winter crop. The adjusted production and value of production for the winter crop results in an adjusted production and value of production for the entire year of 1977. If the adjusted data for 1977 and the actual data for 1975 and 76 are used in estimating an average annual price, the estimate obtained is $9.04. These estimates are obtained from Vegetable 1977 Annual Summary, Acreage, Yield, Production. Crop Reporting Board, USDA, December 23, 1977.

61/ See the preceeding footnote.

62/ This weighted average is obtained from the publication titled Costs and Returns from Vegetable Crops in Florida. The average is based on data found in the March 1977 and the March 1978 publications. The total cost per acre in each year was weighted by the proportion of the acreage in each year as a part of the total.

this elasticity coefficient is that the 14.7 percent increase in price at the farm level would be followed by a 9.9 percent increase in price at the retail level after an EBDC cancellation. 68/ After such a percentage increase, the expected average retail price would increase from $23.04 to $25.32. 69/

The average annual outlay made by consumers for lettuce over the period 1975-77 was $1,252.1 million. 70/ If a cancellation on the use of EBDC fungicides were imposed, this estimated outlay by consumers for lettuce would increase to $1,376.0 million.

Consequently, the additional total annual outlay for lettuce that would be made by consumers would increase by $123.9 million.

Conclusion and Summary

The major part of the negative economic impact of an EBDC cancellation on lettuce would fall on the consumer. By comparison, the additional revenue that would accrue to growers for the U.S. was estimated to be slightly over $59 million. However, the additional outlay that would be made by the consumers of lettuce would be more than twice this amount. In short, the gross loss to consumers far exceeds the change in gross gains to growers of lettuce.

68/ 9.9 = (0.676)(14.7)

69/ Since this price is a three-year average for 1975-77, it is necessarily far below the prices that have existed in 1978.

70/ This estimate is based on an average annual quantity marketed of 54.3 million cwt. and a retail level price of $23.04 per cwt.

Table II-40. Acreage and Production Affected - Lettuce

State	Average acres planted 1975-1977 1/	Percent acres treated-EBDC 1976 2/	Expected annual acres treated with EBDC	1000 CWT. average production 1975-1977 3/	Percent of U.S. production 4/	Percent of U.S. production treated in the states 5/
California	156,376	25	39,092	39,955	73.5	18.4
Arizona	38,067	50	19,033	7,956	14.6	7.3
Florida	9,933	100	9,933	1,436	2.6	2.6

1/ Vegetables 1977 Annual Summary Statistical Reporting Servide, USDA.

2/ Assessment of EBDC use in Agriculture, Part II, USDA/STATE/EPA Assessment Team, April, 1978.

3/ Vegetables 1977 Annual Summary.

4/ Ibid.

5/ The percentage is derived from the information given in column 2 and column 5.

Table 41-a Treatment Cost Per Acre - Lettuce

State	Ave. no. of EBDC appl. per acre. 1/	Lbs. A.I. applied per acre per appl. 1/	Est. material cost per acre with EBDC's 2/	Est. quantity of best alt. use per acre per season 3/	Material cost per acre with alternative 3/	Dif. in material cost per acre with alternative	% Yield lost per acre 4/	Dollar loss from yield reduction based on initial total revenue per acre 5/	Estimated dollar loss from grade reduction	Total dollar value of losses per acre and added material cost	Total revenue per acre Ave. 7/	Losses and added cost as a percent of total revenue per acre
California	7.5	1.6	7.60	5.0	8.75	1.15	12.5	235.25	205.85 5/	442.25	1882.00	23.5
Arizona	2.5	1.6	7.60	5.0	8.75	1.15	12.5	211.75	185.28 5/	398.18	1694.00	23.5
Florida	2.0	1.4	5.32	0	0	5.32	20	329.60	329.60 6/	659.20	1648.00	40.0

1/ Source: Assessment of EBDC Fungicide uses in Agriculture; USDA/State/EPA Assessment Team; Part II An Analysis of Current Impacts to Agriculture from changes in EBDC use patterns, P. 53.

2/ The estimated cost per pound active ingredient for the EBDC fungicide is $1.90. It is an average derived from several current price list.

3/ Source: This information was obtained through personal communication with Dr. Albert Paulus and Dr. Robert McMillan, members of the EBDC Assessment Team. The estimated price per pound active ingredient of copper is $1.75. It is an average derived from several recent price lists.

4/ Source: For California and Arizona the loss incurred from yield reduction would be 12.5 percent of average revenue per acre from 1975-1977. The average revenue is given in the table. For Florida the yield loss would be higher (20 percent) since no alternative would be used and the fungus problem is more severe.

5/ Source: This estimate was derived from information from Dr. Albert Paulus, member of the EBDC Assessment Team. It is estimated that the reduction in grade and quality resulting from treatment with copper instead of EBDC's would reduce the price of a carton of lettuce by 12.5 percent. The dollar loss per acre would be equal to the 12.5 percent of the average revenue per acre for 1975-1977 minus the dollar value of the yield loss.

6/ Source: This estimate was derived from information obtained from Dr. Robert McMillan, member of the EBDC Assessment Team. Untreated lettuce would sell at a price 25 percent lower than that of treated lettuce since the farmer would be of a reduced grade and quality. The estimate of dollar loss per acre would be equal to 25 percent of the average revenue per acre for 1975-77 minus the dollar value of yield loss.

7/ Source: Vegetables: 1977 Annual Summary: Acreage, Yield, Production and Value, Crop Reporting Board, Economics Statistics and Cooperative Service, December 23, 1977.

Table II-41b Percentage Impacts on Output and Price of Yield and Quality Change   lettuce

State	Proportion of U.S. Production treated in the state 1/	Expected percent output loss evaluated at the ave. market price 2/	Est. weighted percent impact on U.S. production	Percent reduction in price for reduced quality 4/	Percent reduction in average U.S. price resulting from quality reduction 5/
California	0.184	12.5	2.3	12.5	2.3
Arizona	0.073	12.5	0.9	12.5	0.9
Florida	0.026	20.0	2.6	25.0	- 6/
Total	0.283		5.8		3.2

1/ Source: Vegetable 1977 Annual Summary, Crop Reporting Board, USDA, December 23, 1977. The proportions are obtained by dividing the percentages in the rightmost column of Table II-40 by 100. The total 0.283 represents the proportion of U.S. production treated.

2/ The percentages are estimates of yield reduction in the respective states that would result from a cancellation of EBDC fungicides. The estimates have been obtained and provided by the plant pathologists on the EBDC Assessment Team.

3/ Each item in the column represents the percentage impact on U.S. production orginiating in the state. The number is the arithmetic product of the proportion in column 1 and the percentage in column 2. The column total represents the weighted percenta change in U.S. supply of lettuce.

4/ The percentages are estimates of percentage reduction in the price received by growers as a result quality reductions. The estimates have been obtained and provided by the plant pathologists on the EBDC assessment team.

5/ Each item in the column represents the percentage reduction in the average price received by growers originating in the State. The number is the arithmetic product of the proportion in column 1 and the percentage in column 4. the column total represents the weighted percent change in the average U.S. price received by growers at the time that the commodity is marketed.

6/ The lettuce production in Florida would be discontinued as a result of an EBDC cancellation. This judgement is contained in Assessment by EBDC Fungicide Uses in Agriculture, Part II, USDA/STATE/EPA

Table II-42. Sample costs of lettuce production at varying yields, 1976 1/

Item	Arizona		California	
Yield cwt. per acre	183 2/	209 2/	224 3/	256 3/
Cost to grow (variable costs) 1/	629.23	629.23	629.23	629.23
Harvest cost @ $3.83 per cwt.	700.89	800.47	857.92	980.48
Fixed costs-machinery and buildings	41.04	41.04	41.04	41.04
Management cost (5 percent of value of crop at the initial yield)	84.75 4/	84.75 4/	94.30 5/	94.30 5/
Total cost	1,455.91	1,555.49	1,622.49	1,745.05

1/ Source: This table is adapted from a production budget prepared for the year 1976 by J. W. Huffman and E. A. Yeary. J. W. Huffman is Farm Advisor-Montery County Cooperative Extension, Parlier California, University of California. E. A. Yeary is Farm Advisor State wide. The data presented in the table are all consistent with the data presented in the original budget prepared by J. W. Huffman and E. A. Yeary. The changes made do not contradict their budget in any way. The changes are several in number, however; first, the unit have been changed from 47 lb. cartons to cwt. and second, the different yields for which costs were estimated have been changed to fit the needs of the analysis. This change was easily accomplished since harvest cost and management cost were the only variable costs in the budget. The extent to which these costs were incremented with the various yield levels was clearly specified in their budget. Thus, total production cost estimates can easily be derived from their table for yield levels not specifically addressed in their budget. In the case of harvest cost, the cost is $3.83 per cwt.. In the case of management cost, an importation of 5 percent of initial total revenue per acre was used.

2/ For the yield levels 183 and 209, the latter would represent the initial yield level and the former would represent the yield level per acre after a 12.5 percent yield reduction resulting from a cancellation

3/ The yield level per acre of 256 would represent the initial yield and 224 would be the estimated yield after a 12.5 percent reduction resulting from an EBDC cancellation

4/ The management cost of $84.75 was derived by inputing 5.0 percent of the initial total revenue for Arizona as a management cost. This total revenue per acre is shown in Table II-140. This inputation for management cost is retained at the lower yield level and lower revenue per acre since the assumption is made that the opportunity cost of management resources will not have changed.

5/ The management cost of $94.30 is an imputation based on 5.0 percent of initial total revenue per acre for California. This total revenue is $1,886.00 as shown in Table II-140. This same management cost inputation ($94.30) is retained even though yield levels may change or the revenue per acre may change. The rationale for retaining this imputation is that the opportunity cost of management resources will not change in response to changes in total revenue per acre on lettuce.

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING EBDC USE ON SPINACH

A. USE: EBDC use on commercially grown spinach

B. MAJOR DISEASE CONTROLLED: Downy mildew

C. ALTERNATIVES:

<u>Major registered chemicals:</u> Copper and captan (RPAR)

<u>State recommendations:</u>

	Number of States Recommending for Diseases Downy Mildew
EBDC	26
Copper	3
Captan	3
No alter. recommended	20

<u>Non-chemical controls:</u> Effective non-chemical control methods are not available.

<u>Efficacy of alternatives:</u> In the heavily affected states (Texas, Maryland, Virginia, and New Jersey) the alternative fungicides, copper and captan, do not provide economic control. It is assumed that none of the currently registered fungicides would be used.

<u>Comparative performance:</u> No alternative fungicide would be used.

<u>Comparative costs:</u> No alternative fungicide would be used. Cost savings from not using EBDC's would average approximately $23 per season including both chemical and application costs.

<u>Conclusion:</u> Economic substitutes for EBDC's on spinach are available.

D. EXTENT OF USE: 43,000 lb (a.i.) EBDC's are applied to 6,000 acres of spinach in Texas, Maryland, Virginia, and New Jersey with an average of 4.5 applications per season. The states breakdown of usage is Texas - 28,300 lb. and 3,300 acres.

E. ECONOMIC IMPACTS:

<u>User:</u> Spinach producers in Texas would shift 100% of their acreage into alternative crops; the likely alternative crop would be onions. Gross revenues would rise by $4.9 million, although profits would remain essentially unchanged as production costs for onions are higher as compared to spinach.

In the Maryland-Virginia area, 65% of spinach acreage would be shifted into soybean production. Net revenues would decline an estimated $80/acre or a total of $175,000.

In New Jersey, 65% of spinach acreage would be shifted into cabbage as the most likely alternative crop. Gross revenue per acre will decline $178 on impacted acres. Net revenue is also expected to decline but value is not known.

<u>Market:</u> An 18.6% decline in productin would be accompanied by a price rise as high as 84.5% at the farm level. Non-users of EBDC would accrue an increase in revenue of $6 million should a price rise of this magnitude occur. Quality of remaining spinach would remain unchanged.

<u>Consumer:</u> Consumer outlays for spinach could rise from $64.1 million currently to $81.9 million as consumption declines from 698,333 CWT to 568,443 CWT. Unit cost at retail level could rise by 56.8%.

<u>Macroeconomic:</u> None expected

F. SOCIAL/COMMUNITY IMPACTS: Not investigated

G. LIMITATIONS OF ANALYSIS:

1. Usage data was estimated by Assessment Team. Survey data were not available.
2. Elasticities used to estimate price impacts may not be accurate for the large protection effects expected.

H. PRINCIPAL ANALYSTS AND DATE

John Bratland, USDA
Gary Ballard, EPA

SPINACH

User Impact

The need for effective fungicide treatment on spinach stems primarily from the damage caused by downy mildew (Peronospora Spinaciae). The disease has the effect of producing a spot on the leaf sections of the plant and additional damage to the stem part of the spinach plant. In cases of severe infestation, the plant can be destroyed by the disease. The disease spreads rapidly; it is common for an entire field of spinach to be destroyed once infestation has occurred (1).

Alternative Control Programs

There are no alternative fungicides registered for use on spinach. An alternative approach to dealing with the disease would be the introduction of varieties of spinach that are resistant to the major disease. Though such varieties are expected to be available, the disease (downy mildew) apparently has the ability to produce new strains which can attack resistant varieties of spinach.

Impact on Production Cost

Table II-44 shows that the average number of EBDC fungicide applications in the affected States is 4.5 per season. Each application involves the use of 1.6 lbs. a.i. per acre. The total cost per season for this type of fungus control program is about $13.68 per acre per season. If the EBDC fungicides were cancelled, there would be no alternative fungicide

used in their place. Consequently, a ban would result in a reduction in cost per acre of $13.68, the cost of the EBDC°s.

Changes in Yield, Quality, and Production

In each of the four affected States-- Texas, Maryland, Virginia, and New Jersey, the expected percentage loss of yield would be 100 percent on currently treated spinach acreage (1). This percentage is the extent of expected losses that would occur as a result of a cancellation on the EBDC fungici Such level of losses would involve a major part of U.S. production of spinach. Table II-43 shows that 35.5 percent of the total U.S. production of spinach is treated with EBDC fungicides in the affected States. This percentage would be the extent of U.S. losses in the production of spinach if a cancellation on EBDC's were imposed.

Changes in Commodity Prices and Farm Income

A cancellation on the use of EBDC fungicides on spinach would have a major impact on the price of this commodity. The extent of the increase in the price would depend on the percentage reduction in quantity produced at current prices and on the responsiveness to price increases of quantities demanded and supplied.

The estimate of price increase that will be derived here will measure the impact on the average U.S. price of a reduction in output in the affected States. In deriving this estimate, it will be assumed that the 35.5 percent reduction in output that would result from an EBDC cancellation represents a 35.5 percent reduction in supply at current prices of spinach.

As indicated above, an estimate of change in price requires some information concerning the responsiveness of quantities demanded and

supplied to price changes. This information is embodied in the price elasticities of demand and supply. As outlined in the Appendix to the vegtetable section, the demand elasticity measures the percentage change in the quantity of the commodity demanded in response to a percentage change in the price of the commodity. The price elasticity that will be used in this assessment is 0.22. This number represents an estimate of the price elasticity of demand at the farm level. 71/

The estimated price elasticity of supply that will be used in this assessment is 0.20. This elasticity measures the percentage change in quantities supplied in response to a one percent change in the price of the commodity (14).

The estimate of change in the farm level price of spinach would take into account the reduction in quantity supplied at current prices and the elasticities of demand and supply. An EBDC cancellation would be expected to

71/ The estimated price elasticity for spinach is derived from the study by P.S. George and G. A. King titled, Consumer Demand for Food Projections for 1980. This farm level elasticity is a product of the elasticity of retail demand for a group of commodities titled "other fresh vegetables" and the average elasticity of price transmission for five (5) fresh vegetables. The price elasticity of retail demand for "other fresh vegetables" is 0.32 and the average elasticity of price transmission for the five fresh vegetables is 0.672.

induce an increase of approximately 84.5 percent in the price of spinach. 72/

A price increase of this magnitude would cause a significant impact on the total revenue accruing to spinach growers in the U.S. The price of spinach (at the farm level) over the period 1975-77 was $17.15 per cwt. An increase of 84.5 percent would increase this price to $31.64 per cwt. The average annual quantity marketed would be reduced from 698,633 cwt. for the period 1975-77 to 568,433 cwt. Consequently, the total revenue accruing to U.S. spinach growers would increase from the average annual $11,979 thousand (for the period 1975-77), to $17,986 thousand.

There would be an increase in the total income of growers continuing to produce spinach in the affected States. In the Maryland-Virginia area and in the

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72/ This estimate is derived through use of the following formula:

$$\% \text{ change in price} = \frac{35.5}{0.22 + 0.20} = 84.5$$

84.5 = the net percentage price change at the farm level for the total U.S. spinach market.
35.5 = the reduction in total U.S. output of lettuce that would occur because of an EBDC cancellation.
0.22 = the estimated price elasticity of demand.
0.20 = the estimated price elasticity of supply.

See the Appendix for further information on the appropriate use of the formula and the assumptions inherent in its use.

New Jersey area, 35 percent of the acreage currently in spinach production would remain so employed after a cancellation on the use of EBDC fungicides. In the Maryland-Virginia area, there would be 764 acres that would remain in spinach production. In New Jersey, there would be 333 acres that would remain so engaged. The yield per acre on this land will not be affected by a cancellation of the EBDC fungicides. Thus, the yield per acre in these two areas will remain at approximately 29.78 cwt. and 68.21 cwt., respectively. A change in price of 84.5 percent would raise the price of Maryland-Virginia spinach from $18.17 per cwt. to $33.52. This increase in price will raise the total revenue per acre from $541.00 to $998.00 on the acreage not directly affected by the cancellation. In New Jersey, a change in price of 84.5 percent would raise the price per cwt. from $19.97 to $36.84. This price increase would shift the total revenue upward from $1,362.00 to $2,513.00. The above described changes in total revenue per acre would increase the total income accruing to spinach growers by $349.1 thousand in the Maryland-Virginia area. The corresponding increase in New Jersey would be $383.3 thousand.

The above described estimates pertain only to the acreage that would remain in spinach production after a cancellation on EBDC use. The loss on the acreage directly affected by such a cancellation would depend on the crops chosen by growers in the affected areas. This issue will be addressed below.

Impact on Affected States and Resulting Shifts in Acreage

It is assumed that the acreage treated with the EBDC fungicides in each of the three affected States will be allocated to alternative crops. This

assumption follows from the estimate that there would be a 100 percent loss in yield on this spinach acreage if there were no treatment with the EBDC fungicide or an alternative. The crops chosen by growers as alternatives would depend on at least two considerations; the profitability of the crop, and the crops already being grown by the grower in addition to spinach.

In the State of Texas, the crop that would be chosen as an alternative to spinach would be selected on the basis of profitability. The crops that appear to be the most likely alternatives to spinach are cabbage, lettuce, carrots, and onions (15). On the basis of recent data on revenue and cost, onions appear to be the most profitable of these alternatives (16).

Spinach grown in Texas is produced in the Rio Grande Valley. The revenue per acre on the onions grown in this part of Texas is approximately $2,145.00. The total cost per acre on onions grown in the valley is about $1,664.92 (16). The profit per acre is thus $480.08. With profits of this size, it is concluded that spinach growers forced into onion production because of an EBDC cancellation would incur important losses. The difference would increase the gross revenue accruing to affected growers in Texas by more than $4.9 million. 73/

In the Maryland-Virginia area, the direction of acreage shifts out of spinach production would be determined by the crops already being grown by the spinach growers in the area. The crops that are also grown by spinach growers in the area are field corn and soybeans (17).

73/ This estimate is obtained by multiplying the extra revenue per acre, $1,251.00, by the acreage affected in the State (see Table II-43).

Of these two alternative crops, soybeans appears to be somewhat more profitable (18). The net revenue or cash receipts per acre is $81.00. It is estimated that the net return on spinach is about twice that of the net return on soybeans. Thus, the loss in net return per acre in "switching" from spinach would be approximately $80.00 per acre. The estimated total loss in net return for all affected growers in the area would be $175 thousand (18).

The loss in total income would be estimated by deriving the difference between net revenue per acre for the two crops and then multiplying the difference by the number of affected acres. Table II-44a shows that the total revenue per acre for spinach in the Maryland-Virginia area is $541.00. The gross revenue per acre on soybeans is $165.00. The difference per acre is $376.00. Consequently, the loss in gross receipts to affected growers in the area is $821 thousand.

In New Jersey, spinach is grown mainly on small, highly diversified farms. There are a large number of crops that would be likely alternatives if EBDC use on spinach were cancelled. These crops would include lettuce, escarole, endive, green cabbage, and green peppers. If growers of spinach in New Jersey were forced out of the production of spinach, the likely alternative crop to which they would turn would be cabbage (20). If growers were forced to make such a change, there would be a loss in total revenue per acre of approximately $178.00. As shown in Table II-44a, the total revenue per acre on spinach is $1,362.00. This dollar amount is an annual average based on the combined production of two seasons--spring and fall. The average annual revnue per acre on spring and fall cabbage in New Jersey over the period

1975-77 was $1,184.00. 74/ The loss in total income to all spinach growers in New Jersey would be approximately $110,360. This estimate is based on the assumption that there would be a loss in gross receipts of approximately $178.00 per acre on the 620 acres that would be affected by a cancellation on the EBDC fungicides.

There are no data currently available that would permit reliable comparison of net returns per acre on spinach and cabbage production in New Jersey.

Summary of Change in Gross Income at the Farm Level

For the U.S. as a whole there would be an increase total revenue of more than $6 million. Of this amount, $732.4 thousand would accrue to growers in the affected States that would remain in spinach production if the EBDC fungicide were cancelled.

In each of the three affected States, there would be significant shifts to alternative crops if the EBDC fungicides were cancelled from use on spinach. The increase in gross revenue that would accrue to affected growers in Texas would amount to $4.9 million. This estimated increase in gross revenue would occur because of a shift from spinach to onion production on the affected acreage. In the Maryland-Virginia area, the crop seen as a likely alternative to spinach is soybeans. Such a shift in acreage would generate an expected

74/ Vegetables 1977 Annual Summary Acreage, Yield, Production and Value Crop Reporting Board, USDA, December 23, 1977. In New Jersey, cabbage is also grown in the summer. However, spinach is not grown in this season. Thus, the summer cabbage crop is not included in the comparison of average annual revenue per acre.

total loss to all growers of $821 thousand. The total loss in gross receipts that would be mounted in New Jersey would be approximately $110 thousand. Thus, for the U.S. as a whole, there would be an increase of $9,976,000 accruing to growers currently engaged in the production of spinach.

Consumer Impact

Changes in the Quantity and Quality of Product Available

There would be no reduction in the quality of the spinach marketed after a cancellation on the use of the EBDC fungicide. Presumably, there would be no production of spinach on the acreage currently treated with the EBDC fungicides.

As noted above, there would be an 18.6 percent reduction in the quantity of spinach marketed in the U.S. This reduction would reflect the decline in the quantity of spinach demanded after the 84.5 percent increase in the farm level price of spinach. This downward shift in quantity marketed would take into account the part of the market adjustment necessary to establish a new "market" or "equilibrium" price after the initial reduction in output imposed by an EBDC cancellation.

Change in Consumer Expenditure

The degree to which the retail price would increase as a result of a cancellation would be determined by the extent of the price change at the farm level and the responsiveness of the retail price to changes in the farm level price. The responsiveness of retail price to change in farm level price can be given or conveyed in an elasticity of price transmission. This elasticity

is a ratio of percentages with the percentage change in the farm level price in the denomenator and the percentage change in the retail price in the numerator. The elasticity of price transmission that will be used in this assessment is equal to 0.672. 75/ The arithmetic product of this elasticity and the percentage change in price at the farm level will give an estimate of the percentage change in price at the retail level. This arithmetic product would give an estimate of price change at the retail level of 56.8 percent. The average retail price for spinach over the period 1975 to 1977 was $91.84 per cwt. (19) An increase of 56.8 percent would add $52.17 to this base price. Thus, the estimated price per cwt. of spinach would be $144.00 after the imposition of an EBDC cancellation.

The change in total outlay made by consumers would take into account the reduction in quantity demanded in addition to the change in price. As indicated above, the total quantity marketed in the U.S. would shift downward from 698,333 cwt. to 568,443 cwt. The average annual outlay for spinach from consumers would consequently increase from $64.1 million to $81.9 million. A cancellation on the use of EBDC fungicides on spinach would result in U.S. consumers of spinach spending an additional $17.8 million.

75/ This elasticity of price transmission is estimated from information contained in a study done by P.S. George and G. A. King. This study was cited in earlier footnotes. The elasticity 0.672 is an average of the price transmission elasticities for five other fresh market vegetables.

Table II-43. Acreage and Production Affected - Spinach (Fresh Market)

State	Average acres planted 1975-1977 1/	Percent acres treated - EBDC 1976 2/	Expected annual acres treated treated with EBDC	Average production 1975-1977 (1000 CWT) 3/	Percent of average production 1975-77 4/	Percent of U.S. production treated in the State
Texas	3,933	100	3,933	164	23.5	73.5
MD-VA	2,183	65	1,419	65	9.3	6.0
New Jersey	953	65	620	65	9.3	6.0

1/ Vegetables 1977 Annual Summary, Crop Reporting Board, USDA

2/ Assessment of EBDC Fungicide Use in Agriculture Part II. April 1, 1978

3/ Vegetables 1977 (cited above).

4/ Ibid

... Spinach (Fresh Market)

State	Ave. number of EBDC applications per acre 1/	Pounds formulation applied per acre per application 2/	Pounds active ingredient applied per acre per application 3/	Estimated EBDC a.i. applied per acre per season	Estimated materials cost per acre with EBDC 4/	Estimated percent yield loss on affected acres without treatment with effective alternative 4/	Estimated dollar loss per acre resulting from reductions in yield	Total revenue per acre (average 1975-1977) 5/	Net difference between dollar yield loss and cost of materials	Net loss per acre on a percent of initial total revenue per acre
Texas	4.5	2	1.6	7.2	13.68	100	894.00	894.00	880.32	98.5
MD-VA	4.5	2	1.6	7.2	13.68	100	541.00	541.00	572.32	97.5
New Jersey	4.5	2	1.6	7.2	13.68	100	1,362.00	1,362.00	1,348.32	98.9

1/ Assessment of EBDC Fungicide Use in Agriculture -Part II. April 1978

2/ Ibid.

3/ Ibid.

4/ The estimated price of the EBDC fungicide is $1.90 per lb. of active ingredient. This is an average derived from several current price lists.

5/ Vegetables 1977 Crop Reporting Board, USDA December 23, 1977

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING
EBDC USE ON CELERY

A. USE: EBDC use on commercial celery production

B. MAJOR DISEASE CONTROLLED: Early Blight and Late Blight

C. ALTERNATIVES:

Major registered chemicals: Benomyl, Chlorothalonil, Anilazine, Copper

State recommendations:

	Number States Recommending for Diseases	
	Early Blight	Late Blight
EBDC	18	20
Benomyl*	9	9
Chlorothalonil	15	15
Anilazine	15	15
Copper	16	16

*RPAR chemical

Non-chemical controls: Not available.

Efficacy of alternatives: Chlorothalonil provides disease control equivalent to EBDC and would be the most likely alternative.

Comparative performance: Yield and quality would be maintained if chlorothalonil were used in place of EBDC.

Comparative costs:

	Season Chemical Cost Per Acre		
	EBDC	Chlorothalonil	Difference
California1/	$15.96	$ 37.57	$21.61
Florida2/	45.98	108.44	62.46

1/ 7 applications per year
2/ 20.2 applications per year

Conclusion: The most likely alternative to EBDC for early blight and late blight would be chlorothalonil. Chlorothalonil is registered and is recommended by several states. Yield and quality will be maintained at a higher chemical cost per acre per season.

D. EXTENT OF USE:

Active ingredient basis: 218,200 pounds (a.i.) EBDC are applied in Florida in an average of 20 applications annually. 33,000 pounds (a.i.) are applied in California in an average of 7 applications annually.

Units treated basis: 3,927 of California's 19,633 acres (20%) of celery are treated annually. 100% of Florida's 20,833 acres are treated annually. California and Florida produce 67.7% and 23.3%, respectively, of U.S. celery produciton for a total of 91%.

E. ECONOMIC IMPACTS:

User: Users in Florida would incur $676,629 in increased production costs or 1.9% of current revenues. Users in California would incur $84,862 increase in production costs or 0.5% of revenues. Users are expected to remain in celery production even though net revenue is reduced.

Market: Quantity and quality of celery marketed is expected to remain unchanged if chlorothalonil is substituted for EBDC by users.

Consumer: No significant impacts.

Macroeconomic: None expected.

F. SOCIAL/COMMUNITY IMPACTS: Not investigated.

G. LIMITATIONS OF ANALYSES: Usage data was based on expert opinion of assessment team members and not on user survey.

H. PRINCIPAL ANALYSTS AND DATE: John Bratland, USDA
Gary Ballard, EPA
September, 1978

Celery

User Impact

A cancellation on the use of EBDC fungicides would have its impacts in California and Florida (1). As shown in Table II-45, these States account for over 90 percent of U.S. celery production. California accounts for 67.7 percent of the U.S. output of celery while Florida accounts for 23.3 percent. However, as shown in the same table, only 20 percent of the acreage is treated with EBDC in California as compared to 100 percent for Florida.

The use of EBDC fungicides on celery has been for the control of two diseases: early blight and late blight. Apparently, the EBDC fungicides are effective in the control of both diseaes.

Alternative Control Program

As indicated in Table II-46a, chlorothalonil would be the preferred alternative to the EBDC fungicides. The explicit assumption is made that if the EBDC fungicides were cancelled, chlorothalonil would be used on all of the affected acreage.

In terms of active ingredient, chlorothalonil would be used in amounts roughly equivalent to that of the EBDC fungicides. In California, 7.91 lbs. (a.i.) of chlorothalonil relative to 8.4 lbs. (a.i.) of EBDC would be used per acre on celery during a season. In Florida where problems with fungi are more serious, there are a greater average number of applications

of fungicide per season than in California. Thus, the quantities of fungicide applied during a season are much greater. In Florida, 24.2 lbs. (a.i.) per acre ofthe EBDC fungicide are applied during the season. With chlorothalonil used as an alternative, 22.83 lbs. (a.i.) per acre would be applied during a growing season.

Impact on Production Cost

In California, the cost per acre of EBDC use is approximately $16 as shown in Table II-46a. This estimated outlay for the EBDC fungicides assumes a cost per lb. (a.i.) of $1.90. If growers in California were forced to use chlorothalonil, the estimated outlay per acre would be $37.57 since the price for this fungicide is approximately $4.75 per lb. (a.i.) Thus, the difference in material cost per acre in California would be about $21.61. In Florida, the per acre material cost for the EBDC fungicides is about $46.00. If chlorothalonil were used as a replacement the expected chemical cost per acre would be approximately $108.44. Thus, the expected difference in per acre cost would be about $62.44 in Florida.

The same theory, rational, and assumptions as were used in the analysis of fresh market tomato prices will be employed here to estimate percentage change in production cost (see pages 11-12 and the Appendix to the vegetable section). Thus, the dollar values in the second column of Table II-46b could be intepreted as estimates of long-run average cost per acre in the two affected States. The estimated average cost per acre in California is $4,320 and in Florida the average cost is estimated to be $3,341 per acre.

The added material cost in California would represent a 0.5 percent increase in production cost. In Florida, the added material cost of $62.46 would represent a 1.9 percent increase in the cost of production.

Change in Yield, Quality and Production

There would be no change in yield or quality with chlorothalonil used as a substitute for the EBDC fungicides.

Changes in Commodity Prices and Farm Income

The extent to which celery prices at the farm level would increase depends on the extent of the material cost increase and on the responsiveness to price increases of quantities demanded and supplied. The elasticity of demand is estimated to be 0.08 at the farm level (3). The elasticity of supply is estimated to be equal to 0.32 (4).

The cost information required to estimate the percentage change in price is the weighted percentage increase in production cost for the U.S. as a whole. In Table II-46b, the weighted sum of the rightmost column, 0.51, is the percentage that will be used in estimating the price change. The estimate of percentage change in price that would result from a 0.51 percent change in

cost of production would be approximately 0.325 percent. 76/ This estimated percent change in price would apply to the U.S. as a whole. Thus, the impact of an EBDC cancellation would have a relatively insignificant impact on celery prices.

The losses that would be incurred at the farm level because of an EBDC cancellation would be limited to the additional costs imposed on growers in the two affected States. In each State, the loss estimate would be derived by the arithmetic product of the average annual acres and the additional cost per acre for the more expensive alternative fungicides. The following listing shows the dollar losses and percentage breakdown.

California	\$ 84,862	11 percent
Florida	\$676,629	89 percent
Total	\$761,491	100 percent

Florida incurs 89 percent of the loss because all of the acreage in this State is treated and because there are three times as many applications per acre per season as in California.

76/ The formula used to derive this estimate would take the following form:

$$\% \text{ change in price} = \frac{0.51}{1 + \frac{0.08}{0.14}} = (0.3245)$$

0.51 = the estimated per unit (cwt.) increase in cost.
0.81 = the percent change in quantity demanded, in response to a one percent change in price for celery (demand elasticity).
0.14 = the percent change in quantity supplied with respect to a one percent change in price (elasticity of supply).

See the Appendix for further information on the appropriate use of the formula and the assumptions inherent in its use.

Impact on Net Return

As indicated above, the added cost per treated acre that would be imposed in California is $21.61. This increase in cost would, of course, have some impact on net return on 20 percent of the celery acreage in California. The following listing shows total cost associated with two different yield levels per acre (24).

Total cost per acre:

900 crates per acre	$3,803
1,000 crates per acre	$4,056

The crates average 60 pounds in weight. From Table II-45, it can be determined that the yield per acre in California is nearly 56,700 pounds or 945 crates. Thus, the estimated cost per acre would be 45 percent of the difference between $4,056 and $3,803 added to $3,803. This estimated cost on acreage yield 945 crates would be $3,917. With $21.61 added to this cost level, the cost per acre after an EBDC cancellation would be $3,939. As shown in Table II-46b, the total revenue per acre in the State is $4,320. After a cancellation, the net return per acre would be $381.00. It is thought that this net return per acre would be more than adequate to retard any acreage shift out of celery into alternative crops.

In Florida, the added cost that would be incurred per acre for alternative fungicides would be $62.46. Production cost information is available for the Everglade area in Florida. This area accounts for almost 69 percent of the acreage known to be treated in this State (7). In this area, the

average yield per acre is 574 crates per acre per season (7). At this yield level, the cost per acre is $3,167 per acre per season (7). However, from Table II-45, it can be determined that the average yield per acre for Florida celery is 35,438 pounds. If crates are assumed to be 60 pounds, the average yield on all Florida acreage is 591 crates per season. This yield level is 3 percent greater than 574 crates. As an approximation of production cost with a yield of 591 crates per season. This yield level is 3 percent greater than 574 crates. As an approximation of production costs with a yield of 591 crates per acre, 3 percent will be added to the production cost given above. 77/ The resulting estimate of production cost is $3,262 per acre. Table II-46 shows that the total revenue acre in Florida celery is $3,341. Thus, before a cancellation, the net return per acre would average $79.00 for the State as a whole. However, for the Everglade area, the net return per acre is $543.73 with a yield of 544 crates and a price per crate of $6.27 (7). An increase in cost of $62.46 per acre would reduce this net return to $481.27. Growers of celery in the Everglades could easily absorb the cost of more expensive fungicides. In this area, growers would not shift acreage to alternative crops because of the added cost that would be imposed by the cancellation of EBDC fungicides.

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77 This estimation procedure is based on the assumption that nearly all items in the production budget vary with yield levels. In actual practice, however, some of these costs will be fixed. Thus, the resulting estimate of costs with the higher yields will be somewhat overstated.

Consumer Impact

Changes in Quantity and Quality of the Product Available

There would be no reduction in grade or quality of celery if the preferred alternative fungicide were used in place of the EBDCs.

Change in Consumer Expenditure

There would be no expected change in consumer expenditures on celery as a result of a cancellation on EBDC use.

Table II-45. Acreage and production affected - Celery

States	Average acres planted 1975 - 1977 1/	Percent acres treated - EBDC 1976 2/	Expected annual acres treated with EBDC	Average annual production 1975 - 1977 (1,000 cwt) 3/	Percent of U.S. production average 75 - 77	Percent of U.S. production treated in the state
California	19,633	20	3,927	11,129	67.7 4/	13.5
Florida	10,833	100	10,833	3,839	23.3 4/	23.3

1/ Vegetables 1977 Annual Summary Crop Reporting Board, USDA.

2/ Assessment of EBDC Fungicide Uses In Agriculture, Part II USDA/STATE/EPA Assessment Team, April, 1978.

3/ Vegetables 1977 Annual Summary.

4/ Ibid.

Table II-46a. Treatment cost per acre and total - celery

State	Ave. number of EBDC applications per acre 1/	Lbs. active ingredient applied per acre per application 2/	Estimated EBDC A.I. applied per acre per season	Estimated materials cost per acre with EBDC fungicides 3/	Estimated quantity of preferred alternative used per acre per season (units A.I.) 4/	Estimated materials cost per acre with the preferred alternative 5/	Difference in material cost per acre with alternative	Total cost impact for the State (1,000 dol.) 6/
California	7	1.2	8.4	15.96	7.91	37.57	21.61	84.9
Florida	20.2	1.2	24.2	45.98	22.83	108.44	62.46	676.6
Total								461.5

1/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978. The specific EBDC fungicides used are maneb, zineb, and mancozeb.

2/ Ibid.

3/ The estimated average price of EBDC fungicicdes is approximately $1.90 per lb. a.i. This price of EBDC is an estimate derived from the average price found in several price lists.

4/ Chlorothalonil is the preferred alternative; Source: Assessment of EBDC Fungicide Uses in Agriculture, Part II.

5/ The price of Chlorothalonil used is an average derived from several price lists.

6/ These estimates are the arithmetic products of the acres treated (Table II-43) and the difference in material cost per acre with the alternative.

Table II-46b. Impacts on Production Cost- Celery

State	Proportion of U.S. production treated in the States 1/	Ave. Revenue per acre 1975-77 (est. ave. cost) 2/	Increase in material cost with alt. fungicide 3/	Est. percent change in cost per acre	Est weight percent im[pact] on U.S. av[e] production
		Dollars	Dollars		
California	0.135	4320.00	21.61	0.5	0.07
Florida	0.233	3341.00	62.46	1.9	0.44
Total	0.368				0.51

1/ Source: Vegetable 1977 Annual Summary Crop Reporting Board, USDA. The proportions are obtained by dividing the percentages in the right most column of Table II-45 by 100. The total 0.368 represents the proportion of U.S. production treated.

2/ Source: Ibid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the appendix.

3/ Source: See Table II-46a

4/ Each item in the column represents the percentage impact on U.S. production cost originating in the state. The column total, 0.51, represents the weighted percent change in average U.S. production cost of commodity that would result from an EBDC cancellation.

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING EBDC USE ON CABBAGE

A. USE: EBDC use on commercially produced cabbage

B. MAJOR DISEASE CONTROLLED: Downy mildew and alternaria leaf spot

C. ALTERNATIVES:

Major registered chemicals: Chlorothalonil and copper

State recommendations:

	Number of States Recommending for Diseases	
	Downy Mildew	Alternaria
EBDC	29	16
Chlorothalonil	17	13
Copper	6	1
No alter. recommended	11	5

Non-chemical controls: Effective non-chemical control methods are not available.

Efficacy of alternatives: Chlorothalonil provides disease control equivalent to EBDC's on diseases affecting cabbage.

Comparative performance: Yields and quality of cabbage would be maintained with use of chlorothalonil in place of EBDC's.

Comparative costs: Switching from EBDC's to chlorothalonil would increase season treatment costs by $14.92/acre in Florida and $5.70/acre in California.

Conclusion: Equivalent disease control can be had by substituting chlorothalonil for EBDC's. Production costs would increase with the substitution.

D. EXTENT OF USE: In Florida, 96,000 lb (a.i.) EBDC's are applied to 16,300 acres in 4.9 applications per acre. In California, 13,300 lb (a.i.) EBDC's are applied to 3,300 acres in 2.5 applications per acre. Current usage of chlorothalonil is not known.

E. ECONOMIC IMPACTS:

User: Cabbage growers in Florida and California would have increased costs of production but would maintain yields and quality by using chlorothalonil.

Market: Quantity and quality available of cabbage would not be significantly changed by loss of EBDC's.

Consumer: Availability and retail price of cabbage would not be significantly changed (less than 1% change in price) by switching to chlorothalonil.

Macroeconomic: No impacts expected.

F. SOCIAL/COMMUNITY IMPACTS: No impacts expected.

G. LIMITATIONS OF ANALYSIS:

1. Usage estimates were made by Assessment Team members. Survey data are not available.
2. Availability of chlorothalonil to replace EBDC use on cabbage is assumed.

H. PRINCIPAL ANALYSTS AND DATE:

John Brathland, USDA
Gary Ballard, EPA
November, 1978

Cabbage

User Impact

The humid and warm environments of California and Florida necessitate the use of effective fungicides in cabbage production. Cabbage in these States is affected by downy mildew (personospona parisitica) and alternaria leaf spot (alternaria brassicae) (1). The EBDC fungicides are used in both States primarily for the control of these diseases.

Alternative Control Programs

Table II-48 shows that chlorothalonil is the fungicide that would be preferred as an alternative if the use of EBDC fungicides were cancelled on cabbage. The alternative, chlorothalonil, would apparently be used on all of the cabbage acreage currently treated with EBDC fungicides in both Florida and California. In those States, chlorothalonil would be applied in the same number of applications per season as the EBDC fungicides. In Florida the average number of applications is 4.9 per acre per season and in California the average number of applications is 2.5

The total quantity of the alternative material that would be applied per acre per season is somewhat less than the quantity of the EBDC fungicide used. In Florida, 5.9 pounds of EBDC active ingredient is applied per season. The quantity of chlorothalonil that would be used in the 5.5 pounds active ingredient. Table II-48a shows that in Califonia, the total quantity of the EBDC fungicides used per acre per season on

cabbage is approximately 4.0 pounds a.i. If chlorothalonil were to replace the EBDC's in this use, the former fungicide would be applied in quantities of approximately 2.8 pounds a.i. per acre per season. In these respective quantities, the cholorothalonil fungicides would apparently be as effective as the EBDC's in controlling the diseases affecting cabbage (1).

Impact on Production Cost

The use of the EBDC fungicides on cabbage in Florida involves a chemical costs per acre of $11.21 per season. The cost estimate assumes a price for EBDC of $1.90 per pound of a.i. As shown in Table II-48a, the added chemical cost of chlorothalonil would be $26.13 on the Florida acreage. This estimate is based on the assumption that chlorothalonil would sell for a price of approximately $4.75 per pound a.i.

On the affected acres in California the cost incurred for the EBDC fungicides per acre per season is approximately $7.60. This estimate is also based on a price of $1.90 per pound a.i. The substitution of chlorothalonil for the EBDC would increase treatment costs per acre to $13.30.

If the assumption is made that the same number of acres would be treated in both States after cancellation of EBDC fungicides, an estimate can readily be made of the additional financial outlay that would be made by all affected farmers in each of the two States. In Florida, the additional cost per acre incurred from the use of chlorothalonil would

be $14.92. Table II-47 shows that the expected annual acres treated are 16,284. Thus, there would be an additional outlay by all affected growers of $242,957. In California the additional cost per acre would be $5.70. If one assumes that all of the 3,333 acres currently treated with the EBDC's would be treated with chlorothalonil the total additional outlay for the State as a whole would be $18,998.

Changes in Yield, Quality and Production

There would be no change in yield or quality with the use of chlorothalonil as a substitute for the EBDC fungicides.

Changes in Commodity Prices and Farm Income

The increase in treatment cost will tend to raise the price of cabbage at the farm level. The extent of this price increase will depend on the amount of the material cost increase and on the responsiveness of price increases of quantities of cabbage demanded and supplied. The estimate of price change sought here is that which would apply to the entire U.S. The total revenue per acre on cabbage production in California is $1,424.00. The additional material cost that would be incurred for the more expensive alternative fungicide is $5.70 as shown in Table II-48b. Added material cost incurred for chlorothalonil would represent 0.4 percent of the proxy estimate of total production cost per acre.

The same theory, rational, and assumptions as were used in the analysis of U.S. fresh market tomato price will be employed here to estimate percentage change in production cost (see pages 4-5 and the Appendix to the

vegetable section). Thus, the estimated average resource cost per acre in Florida is $1798 over the period 1975-77. An increase in material costs of $14.92 would represent an 0.8 percent increase in production cost (Table II-48b). The estimated average cost per acre on cabbage in California is $1,424 (Table II-48b). An additional outlay per acre of $5.70 for chlorothalonil would represent an increase of 0.4 percent in average production cost (Table II-48b). An estimate of the impact of this cost increase on the U.S. price of cabbage would necessitate weighting the percentage increase in both States by the proportion of U.S. production affected by this cost increase. The sum of these weighted percentage change in the price of cabbage would result from the cancellation of EBDC fungicides.

The estimate of percentage change in the price of cabbage that would result from an EBDC cancellation can be derived directly from the estimate of the percentage change in cost per cwt. As indicated earlier, an estimate of change in price requires information regarding the responsiveness to price changes of quantities demanded and supplied. The measures of responsiveness are contained in the price elasticities of demand and supply. With the use of both price elasticities and the estimate of the percentage increase in production cost per cwt, one can obtain the estimate of the percentage change in price that would occur as a result of a cancellation on the use of EBDC fungicides. The estimated increase in price is about 0.6

percent. 78/ Since the estimated increase in price per cwt for cabbage is less than one percent, no attempt will be made to assess the increase in revenue that would accrue to all growers of cabbage because of the estimated increase in price. This approach is in accordance with the procedure outlined in the Introduction to the vegetable section.

The impact of the cancellation on farm income would be felt primarily by those growers of cabbage that currently use the EBDC fungicides. As indicated above the additional outlay that would be made by the affected growers in Florida would be $242.9 thousand (Table II-48a). This number reflects the increased cost incurred for chlorothalonil, the preferred alternative fungicide. In California, this additional outlay would be only $19.0 thousand for all affected cabbage growers in the State (Table II-48a).

78/ This is obtained through the use of the following formula:

$$\% \text{ change in price} = \frac{0.15}{1 + \frac{0.155}{0.1135}} = \frac{0.15}{1 + 1.366}$$

0.634 = The estimated percentage increase in price for cabbage
0.15 = The estimated percentage increase in production cost for cabbage
0.155 = The estimated price elasticity of demand for cabbage
0.1135= The estimated price elasticity of supply for cabbage.

See the Appendix for further information on the appropriate use of the formula and the assumptions inherent in its use.

Consumer Impact

Changes in the Quantity and Quality of the Product Available

There would be no change whatever in the quality of the cabbage market as a result of an EBDC cancellation. The assumption is made that all of the cabbage production currently treated with the EBDC fungicides would be treated with the equally effective alternative, chlorothalonil.

There would be no significant change in the quantity of cabbage marketed at the retail level. The cost increases imposed at the farm level would not be sufficient to induce any adjustment in the level of cabbage production.

Change in Consumer Expenditure

A cancellation on the use of EBDC fungicides on cabbage would not be expected to cause a significant change in either the farm level or retail price. No important change in consumer expenditure would result since cabbage would remain relatively unchanged.

Table II-47. Acreage and production affected - Cabbage.

States	Average acres planted 1975 -1977 1/	Percent acres treated - EBDC 1976 2/	Expected annual acres treated with EBDC	Average annual production 1975 - 1977 1000 cwt 3/	Percent of average annual U.S. production 4/	Percent of U.S. production treated in the state 5/
Florida	17,700	92	16,284	4,399	18.3	16.8
California	8,333	40.0	3,333	1,875	7.8	3.1

1/ Vegetables 1977 Annual Summary Crop Reporting Board, USDA.

2/ Assessment of EBDC Fungicide Use in Agriculture, Part II USDA/STATE/EPA Assessment Team, April, 1978.

3/ Vegetables 1977 Annual Summary.

4/ Ibid.

5/ These percentages are derived from information contained in columns 2 and 5 of this table.

Table II-48a. Treatment cost per acre and total - cabbage

State	Average number of EBDC applications per acre 1/	Lbs., active ingredient applied per acre per application 2/	Estimated EBDC A.I. applied per acre per season	Estimated materials cost per acre with EBDC 3/	Estimated quantity of preferred alternative used per acre per season (units A.I.) 4/	Estimated materials cost per acre with the preferred alternative	Difference in material cost per acre with alternative 5/	Total cost impact for the State (1,000 dol.) 6/
Florida	4.9	1.2	5.9	11.21	5.5	26.13	14.92	242.9
California	2.5	1.6	4.0	7.60	2.8	13.30	5.70	19.0
Total								261.9

1/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978. The specific EBDC fungicides used are maneb and zineb.

2/ Ibid.

3/ The estimated price of the EBDC fungicide is $1.90 per lb. of active ingredient. The price for EBDC is an average derived from several current price lists.

4/ Assessment of EBDC Fungicide Uses in Agriculture, Part II, Chlorothalmil would be the preferred alternative.

5/ The estimated price of the alternative, Chlorothalmil, is $4.75 per lb. of active ingredient. The price for Chlorothalmil is an average derived from several current price lists.

6/ These estimates are the arithmetic products of the acres treated (Table II-47) and the difference in material cost per acre with the alternative.

...-50. Impacts on production cost - cabbage

State	Proportion of U.S. production treated in the States 1/	Ave. Revenue per acre 1975-77 (est. ave. cost) 2/	Increase in material cost with alt. fungicide 3/	Est. percent change in cost per acre	Est weighted percent impac on U.S. ave. production cc 4/
		dols.	dols.		
Florida	0.168	1,798	14.92	0.8	0.134
California	0.031	1,424	5.70	0.4	0.012
Total	0.0199				
					0.146

1/ Source: Vegetable 1977 Annual Summary. Crop Reporting Board, USDA. The proportions are obtained by dividing the percentages in the right most column of Table II-47 by 100. The total 0.199 represents the proportions of U.S. production treated.

2/ Source: Ibid. The average revenue per acre is assumed to be equal to the average cost per acre for the purposes of this assessment. The rationale for this assumption is outlined in the Appendix.

3/ Source: See Table II-48a.

4/ Each item in the column represents the percentage impact on U.S. production cost originating in the state. The column total, 0.146, represents the weighted percent change in average U.S. production cost of the commodity that would result from an EDBC cancellation.

Vegetables

Sources Consulted

1. Assessment of EBDC Fungicide Uses in Agriculture, Part II, USDA/State/EPA Assessment Team, April 1978.

2. Vegetables 1977 Annual Summary, Statistical Reporting Service, USDA, December 23, 1978.

3. This elasticity was obtained through personal communication with Dr. Ronald Mittelhammer, Assistant Professor of Economics at Washington State University, Pullman, Washington. The elasticity is derived from research contained in his doctoral dissertation titled Estimation of Domestic Demand for Salad Vegetables from a Priori Information submitted in 1978.

4. This elasticity was obtained through personal communication with Dr. Michael Hammig of the Commodity Economics Division of the Economics, Statistics, and Cooperatives Service of USDA. The estimate is part of analysis contained in his doctoral dissertation titled Supply Response and Simulation of Supply and Demand for the U.S. Vegetable Industry. The dissertation was submitted to the faculty in 1978.

5. Personal communication with Dr. Albert Paulus, member of the EBDC Assessment Team.

6. Personal communication with Dr. Robert McMillan, Plant Pathologist, University of Florida, Gainesville. Dr. McMillan is also a member of the EBDC Assessment Team.

7. Dr. D. L. Brooke, Costs and Returns from Vegetable Crops in Florida, Season 1976-77 with Comparisons, Food and Resource Economics Department, Agricultural Experiment Station, Institute of Food and Agricultural Services, University of Florida, Gainesville, March 1978.

8. Dr. D. L. Brooke, Costs and Returns from Vegetable Crops in Florida Season 1975-76 with Comparisons, Food and Resource Economics Department, Agricultural Experiment Station, Institute of Food and Agricultural Services, University of Florida, Gainesville, March 1978.

9. Personal communications with Dr. D. L. Brooke, University of Florida, Gainesville.

10. Personal communications with Mr. N. A. Wynn of the Commodity Economics Division of the Economics, Statistics, and Cooperatives Service, USDA.

11. P.S. George and G. A. King, Consumer Demand for Food Commodities in the United States with Projections for 1980, Giannini Foundation memeograph, Number 26, 1971.

12. Luther Tweeten, Foundations of Farm Policy, University of Nebraska Press, 1970.

13. Personal communications with Mr. Steven Raleigh of the Commodity Economics Division of the Economics, Statistics, and Cooperatives Service, USDA.

14. This elasticity was derived in a study done by Marc Nerlove and W. Addison. It is cited in Ruben C. Buse and Daniel W. Bromley, Applied Economics, Resource Allocation in Rural America.

15. This list of alternatives was obtained through personal communications with Dr. Samuel Cotner, Extension Horticulturalist, Texas Agriculture Extension Service, The Texas A&M University System, College Station, Texas.

16. 1976 Budgets for the Majo Rio Grande Valley Vegetables, Thomas D. Longbrake and Alan W. Reichardt, Extension horticulturalist and area economist, respectively, the Texas A&M University System, College Park, Texas.

17. Personal communication with H. H. Hocker of the Department of Agriculture and Resource Economics, University of Maryland and Dr. Charles McClary, Extension Horticulturalist at the University of Maryland.

18. Farm Data Manual; Planning Data for Farming in Maryland Input-Output, Costs and Returns (August 1977), George Stevens, Department of Agricultural and Resource Economics, University of Maryland.

19. Personal communications with Mr. Joseph Podany of the Commodity Economics Division, Economics, Statistics, and Cooperatives Service, USDA.

20. This information was obtained through personal communication with Dr. P. T. Dhillan of the Department of Agricultural Economics and Marketing, Cook College, New Jersey Agricultural Station, Rutgers, State University of New Jersey, New Brunswick, New Jersey.

21. Personal communication with Dr. James Kantzes, Plant Pathologist, University of Maryland and member of the EBDC Assessment Team.

22. Ohio Crop Enterprise Budgets 1978 Specialty Crops, Prepared by Area and State Extension Farm Management Faculty, Department Agricultural Economics and Rural Sociology in consultation with Area and State Extension Faculty in the Department of Agronomy, Department of Horticulture, Ohio State University.

23. Personal communications with Mr. Charles Porter of the Commodity Economics Division of the Economics, Statistics, and Cooperatives Service, USDA.

24. Cost and Practice for Row Crops in Ventura County, Cooperative Extension, University of California, Ventura California (December 1976). These cost estimates do not include returns to managerial skill or entreprenerial talent.

Appendix: Economic Impact of a Ban on the Use of EBDC Fungicides on Vegetable Crops and Peanuts

"Practical Techniques for Approximating Commodity Price Impacts of Pesticide Cancellations When Elasticities Are Available"

Introductory Comments

In the part of the EBDC assessment focusing on vegetables, certain formulas have been used for the purpose of approximating the percentage change in price of the commodities directly affected by a cancellation. The use of these formulas represents a simplified technique for approximating the impact on price of a pesticide cancellation. The word "approximating" is used for the purpose of emphasizing the fact that the method employed does not represent standard statistical or econometric techniques of estimation. The techniques should be viewed as carefully formulated "rules of thumb" yielding results that must be interpreted in light of certain strictly defined assumptions. These assumptions represent certain simplifications made for the purpose of making the analysis more manageable. The assumptions will be listed in this appendix.

An important part of the economic impact of a pesticide cancellation is the effect of such a cancellation on the price of the commodity on which the pesticide is used. This analysis has been prepared for the purpose of showing how these formulas are derived and used. These formulas are derived from a simple two equation model of supply and demand. This model will be outlined briefly below.

The formulas were derived for the purpose of dealing with three different types of impacts that can occur as a result of a cancellation.

These impacts would include the following:

(1) A change in cost per unit of the commodity with the change arising because of the use of a more expensive alternative pesticide;

(2) A change in yield that could result from the use of a less efficient alternative pesticide or the use of no alternative pesticide;

(3) A change in the quality of the commodity marketed with the change resulting from the use of a less effecitve alternátive or the use of no alternative.

Each of these types of impact require a different type of an analysis since each would involve different types of adjustments within the context of the supply and demand model. Increases in cost and reductions in yield involve shifts or changes in supply at the farm level. Reductions in quality have the effect of decrease in demand for the commodity at the farm level. Thus different mathematical formulas are required for each of these cases.

The Simple Supply and Demand Equations with Definitions

The main purpose of this analysis is that of demonstrating how certain formulas are derived from the simultaneous supply and demand equations. In their simplest form these equations could be expressed in the following way:

(1) $P_D = a - b\,Q_D$

(2) $P_S = c + d\,Q_S$

The following definitions apply to equations (1) and (2):

P_D = This notation represents the demand price of the commodity for the U.S. as a whole. The price is a function of Q_D.

Q_D = This symbol represents the quantity of the commodity that would be demanded at a particular U.S. price.

a = a constant intercept.

b = A measure of slope – the slope showing change in P_D = with respect to change in Q_D

P_S = This notation represents the supply price of the commodity for the U.S. This variable is exactly equal to per unit cost of the commodity. P_S is a function of Q_S.

Q_S = This variable is the quantity of the commodity that would be supplied at a particular price P_S.

c = A constant intercept.

d = A measure of change in P_S with respect to change in Q_S.

Both equations (1) and (2) can be solved for the independent variable, Q_D and Q_S respectively. The resulting equations would take the following form:

$$(3)\quad Q_D = \left(\frac{a}{b}\right) - \left(\frac{P_D}{b}\right)$$

$$(4)\quad Q_S = \left(\frac{P_S}{d}\right) - \left(\frac{c}{d}\right)$$

In equations (3) and (4), Q_D and Q_S are functions of P_D and P_S respectively. Thus, depending upon the way these equations are expressed, price can be a function of quantity or vice verse.

Equations (3) and (4) can be solved for a common price; that is, a price at which P_D equals P_S. Such a common price would be a market price or equilibrium price.

The term "market price" will be used in this analysis. This price will be represented by the symbol P_m. This price will be defined in the following way:

$$(5) \quad P_M = P_D = P_S$$

If such a price exists, it will be at a point on the supply and demand functions at which the following equality holds:

$$(6) \quad Q_D = Q_S = Q_m$$

The term Q_m would, of course, be the market quantity. The market quantity is the quantity demanded and supplied at the market price. If such an equality exists at a positive price P_M, then equations (3) and (4) can be set equal to each other:

$$(7) \quad \left[\frac{a - P_D}{b}\right] = \left[\frac{P_S - c}{d}\right].$$

Since the equality $P_M = P_D = P_S$ is assumed to hold, equation (7) can be solved for a common value P_M.

$$(8) \quad P_M = \left[\frac{ad + bc}{b + d}\right]$$

When mention is made of market price in the remainder of the analysis, the type of solution given in (8) is that to which reference is made.

The relationships between prices of the commodity and quantities of the commodity can be depicted in a simple and familiar diagram. Such a diagram is given in figure 1.

figure 1.

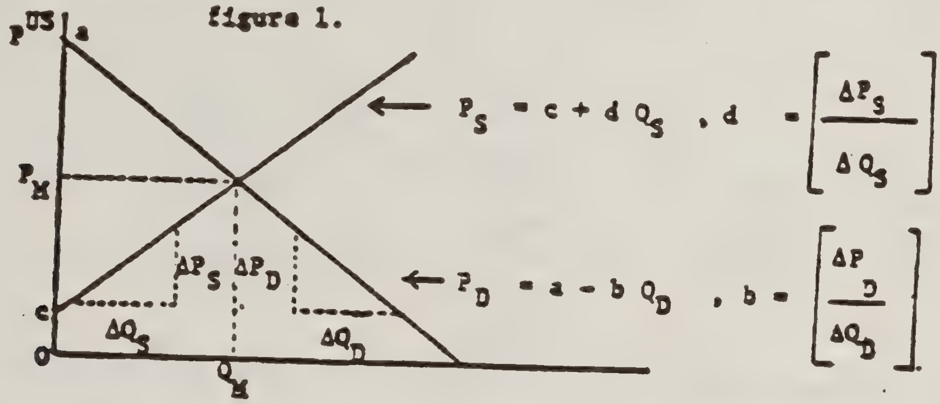


Figure 1 shows the intersection of a supply and demand function with the market price P_M and the market quantity, Q_M, generated at the point of insection. The line with intercept, c, and slope d is the supply function. In effect, the line shows that per unit cost (as measured by P_S) increases with increases in the level of production, Q_S. The line with intercept, a, and slope, - b, is the demand function.

The Concept of Elasticity

The formulas permit one to use estimates of supply and demand elasticity that have been derived or estimated in other economic analyses. The equations and the diagram presented above permit a clear explanation of the notion of elasticity. In general terms it can be said that elasticity is a ratio that shows the percentage change in a dependent variable with respect to a percentage change in an independent variable. The price elasticity of demand would measure the percentage change in quantity demanded of a commodity with respect to a percentage change in price of the commodity. This elasticity would be expressed as a ratio

with the percentage change in quantity in the numerator and the percentage change in price in the denominator. A demand elasticity is given in equation (9).

$$(9) \qquad E_D = \frac{\left[\frac{\Delta Q}{Q_D}\right](100)}{\left[\frac{\Delta P_D}{P_D}\right](100)} = \frac{\left[\frac{\Delta Q_D}{Q_D}\right]}{\left[\frac{\Delta P_D}{P_D}\right]} = \left(\frac{\Delta Q_D}{\Delta P_D}\right)\left(\frac{P_D}{Q_D}\right)$$

The following definitions apply to the elasticity given in equation (9).

E_D = This symbol will be used to designate the price elasticity of demand,

Q_D = The quantity demanded of the commodity,

P_D = The demand price of the commodity,

ΔQ_D = The change in the quantity demanded,

ΔP_D = The change in the demand price of the commodity.

The price elasticity of supply is a similar ratio; the numerator is the percentage change in quantity supplied of the commodity and the denominator is the percentage change in price of the commodity. Equation (10) gives the supply elasticity in the form that will be used in the remainder of the analysis.

$$(10) \qquad E_S = \frac{\left[\frac{\Delta Q_s}{Q_s}\right](100)}{\left[\frac{\Delta P_s}{P_s}\right](100)} = \frac{\left[\frac{\Delta Q_s}{Q_s}\right]}{\left[\frac{\Delta P_s}{P_s}\right]} = \left[\frac{\Delta Q_s}{\Delta P_s}\right]\left[\frac{P_s}{Q_s}\right]$$

The following definitions apply to the supply elasticity given in (10).

E_s = The symbol that will be used to designate the elasticity of supply.

Q_s = The quantity of the commodity supplied at a particular time.

P_s = The price that must exist for a given quantity of a a commodity to be supplied.

ΔQ_s = The change in the quantity of a commodity supplied.

P_s = The change in the supply price of the commodity.

As indicated above, the elasticities used in these formulas are from estimates of supply and demand derived from other economic studies. In most cases, the elasticities used in this study have been derived within the context of models of a somewhat more complex nature than the one used here. The results obtained from this use of elasticities must be interpreted within the context of certain assumptions.

<u>Assumptions</u>

(1) The assumption is made that the linear form of the demand and supply function will serve as satisfactory approximations of the actual schedules of demand and supply for the commodity.

(2) The price of each affected commodity is assumed to be determined by the forces of supply and demand. These forces would be characterized by the intersection of a demand and supply function and the emergence of a common "market price".

(3) A weighted average price for the U.S. covering several time periods is assumed to be a sufficiently accurate approximation of the "market price" for the commodity. This weighted average would take account of the proportion of total U.S. production accounted for by each state or region. The nature of this weighted average is outlined below in this appendix.

(4) The assumption is made that each of the three types of impacts imposed by a pesticide ban can be represented by a shift of either the demand or supply function. The shift is assumed to result in a new market price for the commodity or crop being considered in the assessment. In reality, this shift in price can be too small to be important.

(5) The extent of the shift in either the demand or supply function is assumed to be relatively small. The rationale for this assumption will be made clear in the specification of other assumptions below.

(6) The shifts of the demand or supply functions are assumed to be of a specific type. The function must be assumed to shift by a constant absolute amount at all points along the relevant segment of the function. Thus, the function, after the shift, would be viewed as parallel to the initial position of the function. In reality such a shift would rarely occur. However, for relatively small shifts this assumption permits a sufficiently accurate approximation of the percentage change in price of the commodity.

(7) The elasticities used in the formulas are assumed to be valid approximations of the elasticities that would obtain at the average market price used as a base in estimating the percentage change in the percentage change in the price of the commodity.

(8) The elasticities of supply and demand at the new market price are assumed to differ insignificantly from those of the initial market price. This assumption is satisfied if the shift in the supply or demand function is relatively small.

(9) The markets for related commodities are assumed to be free of disturbances during the time period necessary for the market to move from one market price to another. (Commodities can be related in the sense that they are substitutes in production or that they are substitutes or complements in consumption)

(10) No allowance is made for the time period necessary for a new market price to emerge once a pesticide cancellation has been imposed. The assumption is made that the adjustment necessary to achieve a new market price occur "instantly". In reality, such an adjustment would not occur immediately but could cover a time period extending over one or more seasons.

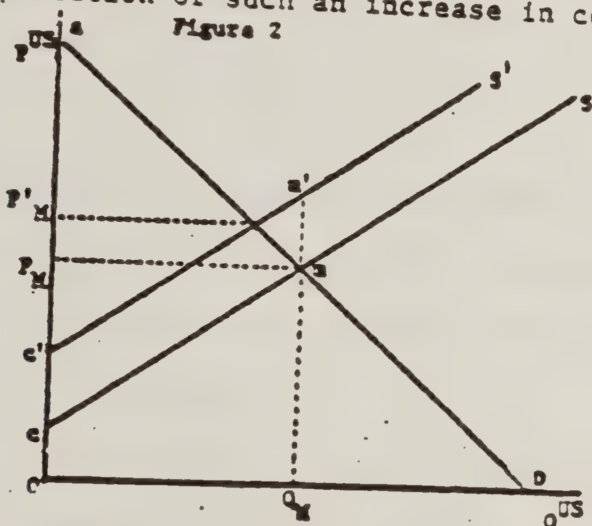
The Formulas and Their Uses

The use of the formulas can best be explained by relating the three types of impacts mentioned above to a simple diagram like figure 1.

- AN INCREASE IN PER UNIT COST OF PRODUCTION

The first type of impact mentioned above is the increase in per unit cost incurred in the use of a more expensive pesticide. Figure 2 shows the implication of such an increase in cost.

Figure 2



This diagram is similar to figure 1 except that the demand function is designated by a D and the original supply function by cS. The market price is achieved when the quantity demanded equals the quantity supplied at a given price. This price, P_M is obtained at the intersection m. The distance, m' - m, shows the dollar increase in cost-per-unit of the commodity that would result from the use of more expensive pesticides in place of the one being banned. It is important to note that the distance, c' - c, is equal to the distance, m' - m. This equality implies that the increase in cost per unit can be depicted by an upward shift of the supply curve by an equal absolute dollar amount at all points along a limited or restricted segment of the curve supply curve.

The new market price that results from the increase in per unit cost is shown by P'_M. Thus, the formula permits an estimate of the value $\left[(P'_M - P_M) / P_M \right] 100$

This estimate would require the use of the following type of formula:

$$(11) \qquad \% \Delta P_M = \left[\frac{\left[\% \Delta P_S \right]_{Q = Q_M}}{1 + \left(\frac{E_D}{E_S} \right)} \right] .$$

The following definitions apply to the formula in (11):

P_M = The market price of the commodity at the farm level.

$\% \Delta P_M$ = The percentage change in the market price at the farm level.

P_S = The measure of per unit production cost of the commodity at the farm level.

$\left[\% \Delta P_S \right]_{Q = Q_M}$ = The percentage change in per unit production cost imposed as a result of a pesticide ban. (Note that the percentage is measured at $Q = Q_M$).

E_D = The price elasticity of demand for the commodity at the farm level (defined above).

E_S = The price elasticity of supply at the farm level (defined above).

The derivation of the formula in equation (11) would be accomplished by first defining the new supply function or per unit cost function. After the per-unit cost increase, the per unit cost function for the

US would be given by:

(12) $$P_S = c' + dQ_S$$

After the per unit cost increase of $(c' - c)$, the new market price would be given by the following equation:

(13) $$P'_M - P_M = \left[\frac{bc' - bc}{b + d}\right] = \left[\frac{c' - c}{1 + \left(\frac{d}{b}\right)}\right]$$

If the numerator and the denominator are multiplied by the ratio P_M/Q_M, the above equation becomes,

(15) $$P'_M - P_M = \left[\frac{(c' - c)\left(\frac{P_M}{Q_M}\right)}{\left(\frac{P_M}{Q_M}\right) + \left(\frac{d}{b}\right)\left(\frac{P_M}{Q_M}\right)}\right]$$

The elasticity of demand can be measured at the point where $P_D = P_M$ and $Q_D = Q_M$. This elasticity can then be expressed,

(16) $$E_D = \frac{\left[\frac{\Delta Q_D}{Q_M}\right]}{\left[\frac{\Delta P_D}{P_M}\right]} = \left[\left(\frac{\Delta Q_D}{\Delta P_D}\right)\frac{P_M}{Q_M}\right] = \left[\frac{P_M}{b\ Q_M}\right]$$

(17) $$P'_M - P_M = \left[\frac{(c' - c)\left(\frac{P_M}{Q_M}\right)}{\left(\frac{P_M}{Q_M}\right) + d\ E_D}\right].$$

If the numerator and the denominator of the right side of (17) are multiplied by the ratio Q_M / P_M, this equation becomes,

$$(18) \qquad P'_M - P_M = \left[\frac{(c' - c)}{1 + E_D \left(\frac{dQ_M}{P_M} \right)} \right]$$

The elasticity of supply is evaluated at the point at which $P_S = P_M$ and $Q_S = Q_M$. The price elasticity of supply can thus be expressed:

$$(19) \qquad E_S = \left[\frac{\frac{\Delta Q_S}{Q_M}}{\frac{\Delta P_S}{P_M}} \right] = \left[\frac{\Delta Q_S}{\Delta P_S} \right] \left[\frac{P_M}{Q_M} \right] = \left[\frac{P_M}{dQ_M} \right]$$

The equation that defines the difference market price, 18, can thus be expressed:

$$(20) \qquad P'_M - P_M = \left[\frac{(c' - c)}{1 + \left(\frac{E_D}{E_S} \right)} \right]$$

Both sides of the equation in (20) can be multiplied by the ratio $(100/P_M)$. The equation thus becomes:

$$(21) \qquad \% \Delta P_M = \left[\frac{100 \left[\frac{c' - c}{P_M} \right]}{1 + \left(\frac{E_D}{E_S} \right)} \right]$$

The numerator in the right side of equation (21) increases the percentage change in per-unit cost. Since the initial unit cost is $P_S = P_M$, it is measured at $Q_S = Q_M$. Thus, the equation becomes:

$$(22) \qquad \% \Delta P_M = \left[\frac{\left[\% \Delta P_S \right]_{Q = Q_M}}{1 + \left(\frac{E_D}{E_S} \right)} \right]$$

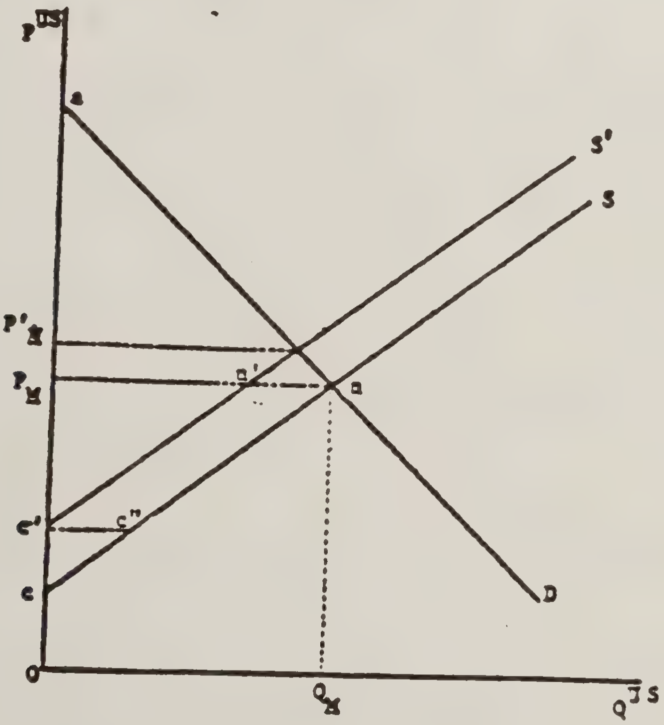
This equation is the formula given in (11) above.

The use of formula in equation 22 rests on all of the assumptions given above. The percentage change given by the formula is an approximation that can only be properly interpreted in light of these assumptions.

- A REDUCTION IN YIELD

A new market price would emerge as a result of a reduction in yield imposed by a pesticide ban. Figure 3 depicts the consequences of a reduction in yields.

figure 3



The distance nn' shows the extnet of the reduction in supply that results from the yield reduction. In figure 3, P'_M represents the new market price that would result from the reduction in supply. Note should be taken of the fact that the distance c'c" is equal to the distance n n' in figure 3. This equality implies that the reduction in yield can be depicted by a horizontal shift of the supply curve by an equal absolute amount at each point along a restricted part of the supply curve. (see the list of assumptions outlined above).

As in the case of per unit cost increases, a formula can be derived which permits an estimate of the percentage change in price that would result from a yield reduction induced by a pesticide ban. This formula would take the following form:

$$(23) \qquad \%\Delta P_M = \left[\frac{\left[\%\Delta Q_S\right]_{P = P_M}}{(E_S + E_D)} \right]$$

The terms in this formula that also appeared in the preceeding formula will retain their same meaning. The new terms would be defined in the following way:

Q_S = The quantity of the commodity that would be supplied in the U.S. if certain per unit costs were covered by market price.

$\left(\%\Delta Q_S\right)_{P=P_M}$ = A percentage shift in the supply function evaluated at the initial market price.

The percentage shift in the numerator of equation (23) is equivalent to the measure $100\left[(n' - n)/n)\right]_{P = P_M}$

The first step in deriving the formula involves a determination of the algebraic relationship between vertical shifts of the supply function (increases in per unit cost) and horizontal leftward shifts in this function. Horizontal leftward shifts would correspond to reductions in output such as would arise because of yield reductions. The supply function given above was:

(24) $$P_S = c + dQ_S \cdot$$

The constant d in this equation shows the change in per unit cost incurred as a result of an increase in the quantity produced. That is:

(25) $$d = \frac{\Delta P_s}{\Delta Q_s} \cdot$$

Thus,

(26) $$\Delta P_s = d\Delta Q_s$$

The slope of the supply function can be used to express the distance between an initial supply function and a new supply function. A horixontal shift of the supply function to the left would reflect a reduced yield or a reduced maximum output at each level of per unit cost. The slope d can be used to measure the vertical distance between the initial supply function and the new supply function once the horizontal shift has occurred. The expression $(\Delta Q)_{P=P_M}$, will be used to designate the extent ofa horizontal shift of the supply function. This measure is equivalent to the destance, n' - n, in figure 3. The shift in the supply function can be defined in terms of the slope d and the algebraic difference between the intercepts, c and c'.

(27) $$\left[\Delta Q\right]_{P = P_M} = \left[\frac{c' - c}{d}\right]$$

From an equation derived above, the following relationship was defined:

(28) $$P'_M - P_M = \left[\frac{c' - c}{1 + \left(\frac{d}{b}\right)}\right]$$

From the information given in (27), it is possible to express equation (28) in the following way:

(29) $$P'_M - P_M = \left[\frac{d\left[\Delta Q_S\right]_{P = P_M}}{1 + \left(\frac{d}{b}\right)}\right]$$

Equation (29) expresses the change in market price in terms of a vertical upward shift in the supply function. However, the price change can be expressed in terms of a horizontal leftward shift simply by dividing the numerator and the denominator by d. Thus,

(30) $$P'_M - P_M = \left[\frac{\left[\Delta Q_s\right]_{P = P_M}}{\left(\frac{1}{d}\right) + \left(\frac{1}{b}\right)}\right]$$

The extent of the price change is determined by the reduction in supply and the elasticities of supply and demand. The task of including the elasticities is accomplished by first multipying the numerator and the denominator of 30 by the ratio P_M/Q_M. The resulting equation is the following:

(31) $$P'_M - P_M = \left[\frac{\left(\frac{P_M}{Q_M}\right)\left[\Delta Q_S\right]_{P = P_M}}{\left(\frac{P_M}{dQ_M}\right) + \left(\frac{P_M}{bQ_M}\right)}\right].$$

If the supply elasticity is evaluated at the point at which $P_S = P_M$ and $Q_S = Q_M$ both hold and if the demand elasticity if evaluated at the point at which $P_D = P_M$ and Q_D and $Q_D = Q_M$' then equation 31 becomes:

$$(32) \qquad P'_M - P_M = \left[\frac{P_M \left[\frac{\Delta Q_S}{Q_M} \right]_{P = P_M}}{E_S + E_D} \right].$$

Both sides of equation (32) can be multiplied by the ratio $100/P_M$. One this is done, the following equation emerges

$$(33) \qquad \% \Delta P_M = \left[\frac{\left[\% \Delta Q_s \right]_{P = P_M}}{E_s + E_D} \right].$$

This is the formula given in equation (23) above. Thus, the second formula has been derived from the simultaneous supply and demand equations. This formula would be used to estimate the percentage increase in commodity price that would result from the yield reductions imposed by a pesticide ban.

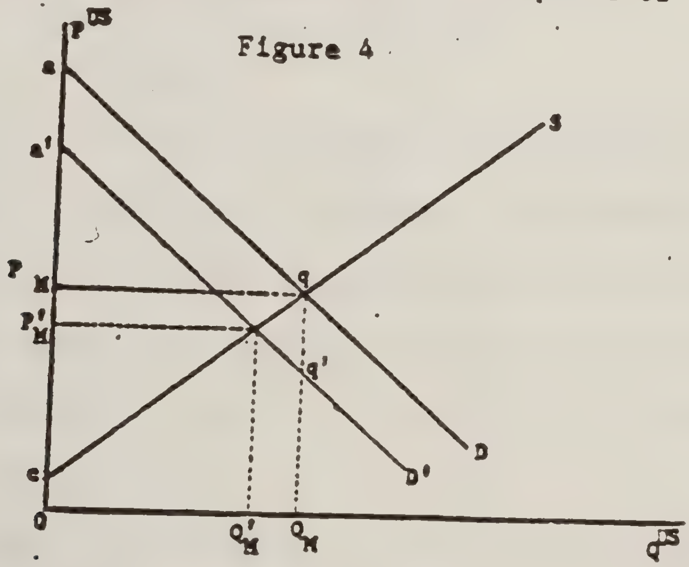
Again it must be stressed that the use of the formula in (33) must be interpreted in light of the explicitlyassumptions presented above. One additional assumption must be made explicity regarding the use of the formula in equation (33). The numerator in the formula is a weighted sum of estimated percentage yield reductions in the various states affected by the pesticide cancellation. The initial estimates of yield reductions are presented as percentage reductions per acre. The assumption is made that this reduction is the equivalent of the percentage reduction for a constant cost per unit of production.

The assumption emplies a corollary assumption that total costs of production will decline by the same percentage as the percentage decline in output of the commodity. In most cases there would not be a strict equality between these percentages. However for the purposes of approximating percentage change in price, this assumption will be retained.

-REDUCTIONS IN QUALITY

A reduction in quality is the third type of impact that can result from a ban on a pesticide. A reduction in quality of the commodity would mean that farmers would receive a lower price for the same physical quantity marketed. Thus, a reduction in quality has the effect of reducing the demand for the commodity. Figure 4 depicts this reduction in demand and the resulting reduction in the price of the commodity.

Figure 4



In Figure 4, aD depicts the initial demand function. The line cS shows the supply function for the commodity. The supply and demand functions intersect a q generating the U.S. market price P_M at the market clearing quantity Q_M. The distance $(q' - q)$ shows the absolute dollar reduction in the price offered to affected farmers at the time the commodity is

marketed. In Figure 4, P'_M shows the new market price that would result from the quality reduction imposed by a ban on the pesticide.

In respect to Figure 4, it is important to note that the distance (a' - a) is equal to the distance (q' - q). This equlity implies that the reduction in price imposed because of quality reductions can be represented by a vertical downward shift in demand curve by an equal absolute dollar value at each point along a restricted segment of the demand curve. The formula given in (34) permits an estimation of the percentage change in price that would be imposed on the U.S. market as a conseauence of the ban.

$$(34) \qquad \% \Delta P_M = \left[\frac{\left[\% \Delta P_D \right]_{Q = Q_M}}{\left(\frac{E_S}{E_D} \right) + 1} \right]$$

In equation (34), E_S and E_D are respectively the price elasticity of supply and the price elasticity of demand. The numerator on the right side of equation (34) is the percentage downward shift in the U.S. demand function for the commodity at the farm level. This numerator is equal to the measure 100 (q' q)/q at $Q=Q_M$. The distance (q' - q) is depicted in Figure 4.

The derivation of the formula in (34) is accomplished by defining the new demand function and the new market price that emerges after adjustment to the downward shift in demand. The new demand function is.

$$(35) \qquad P_D = a' - bQ_D$$

The new market price would be given by

$$(36) \qquad P'_M = \left[\frac{a'd + bc}{b + d}\right]$$

The difference between the old and new market price is given by the following equation.

$$(37) \qquad P'_M - P_M = \left[\frac{a'd - ad}{b + d}\right]$$

$$= \left[\frac{(a' - a)}{\left(\frac{b}{d}\right) + 1}\right]$$

Equation (37) can be modified so that the elasticities of demand and supply are included. If the numerator and denomenator are multiplied by $(P_M\ Q_M)\ /\ Q(Q_M\ P_M)$, these elasticities would be measured at the points where $P_D = P_M$, $Q_D = Q_M$, $P_S = P_M$ and $Q_S = Q_M$. The modified equation would be

$$(38) \qquad P'_M - P_M = \left[\frac{a' - a}{\left(\frac{E_S}{E_D}\right) + 1}\right].$$

The numerator in (39) is equivalent to the percentage reduction in demand evaluated at $Q = Q_M$; thus,

$$(40) \qquad \% \Delta P_M = \left[\frac{\left[\% \Delta P_D\right]_{Q = Q_M}}{\left(\frac{E_S}{E_D}\right) + 1}\right].$$

This is the formula given in (34) above. The formula has been derived from the simultaneous equations of supply and demand. This equation or formula is used to estimate percentage changes in price resulting from reductions in quality of the commodity.

Once again it must be point that this formula yields results that must be interpreted within the context of the assumptions outlined above. However, there are two additional assumptions which relate to quality reductions. It is assumed that.

(1) There is a constant standard of quality evaluation which does not change with the volume of quantities marketed. For the purposes of this assessment, this assumption is assumed to hold over the relevant range of quantities of the commodity marketed before and after a cancellation of the pesticide. In reality it is possible that if the supply of good quality products is low, wholesalers may expand the range of characteristics over which a product is judged to be of best quality. When the supply of good quality products is high, on the other hand, standards for judgement of best quality may become quite stringent. Thus, the assumption of the demand function may be valid over a restricted range of quantities marketed.

(2) It is explicitly assumed that a reduction in the quality of a fresh market commodity (as a result of a pesticide cancellation) and the subsequent reduction price does not induce the marketing of the commodity in the process market. The latter would be a market in which quality standards are less stringent since the commodity is processed for canning. Certainly this assumption could not hold for major reductions in the quality of fresh market commodities. If a process market for the fresh market commodity were to exist, it is likely that a major reduction in the quality (and price) would induce growers to market the commodity in the process market.

Measures of Initial Impact

The formulas given above are appropriate for estimating the percentage change in commodity price for the U.S. market as a whole. In addition to the information of supply and demand elasticity, the formulas require a measure of initial impact which takes into account the regions affected by a cancellation the extent to which each of the respective regions is affected. The impacts of pesticide cancellation usually affect various States or regions to differing degrees. This differential in the extnet of impact between regions means that a weighted average impact must be derived for use in the formulas. The percentage change in yield, cost or transaction price must be weighted by the proportion of U.S. production thus affected. The sum of these weighted measures would give the relative initial impact is that which must be used in the formulas. The mechanics of this weighting process will be outlined below.

The following definitions will be used in expressing the relative initial impacts of pesticide cancellations:

i = the subscript used to designate the region of State

m = the total number regions of States affected by a cancellation (This number will differ between crops and between pesticides.)

n = the total regions or States in the U.S.

r_i = the proportion of total U.S. production in region i.

Though the markets for all commodities are related, the assumption is made in this analysis that supply and demand functions defined for the U.S. marketStates as a wholed are weighted averages of the functionswhich characterize markets in the individual regions.

Since the regional supply and demand functions are assumed to be similar or identical in form to those defined for the U.S. in equations (1) and (2), only the notation will be presented here.

P_S^i = this notation represents demand price for the commodity in region i. The price is assumed to be a function of quantity demanded Q_D^i and per capita income Y. This demand function would reflect the combined demand for the commodity within the region and the demand outside of the region.

P_M^i = the symbol represents the supply price in region i. The price is exactly equal to per unit cost at the various possible quantities of output that can be produced.

P_M^i = this price notation would represent the market price in region i. This price would be equal to P_D^i and P_S^i at same quantity of the commodity produced and marketed. This price can only be defined as a market equilibrium price if an approximate equilibrium exists within and between the remaining regions in the U.S.

Q_D^i = this variable represents the quantity dependent function for region i. It would be the regional counterpart of equation (3) above. Equation (3) defines the quantity dependent demand function for the total U.S. market for the commodity. The demand function would reflect the demand for the commodity originating from within region i plus the demand for the commodity originating outside of the region.

Q_S^i = this symbol represents the quantity dependent supply function for region i. It represents the regional counterpart of equation (4). Equation (4) defines the quantity dependent supply function for the entire U.S. market for the commodity.

Q_M^i = this notation would be market quantity: the amount produced and sold at the market price P_M^i. Of course, it would occur at the point at which $Q_S^i = Q_D^i$.

The regional supply and demand functions are related to the U.S. demand and supply functions in the following way:

$$(41)\quad Q_D = \sum_{i=1}^{n} Q_D^i$$

$$(42)\quad Q_S = \sum_{i=1}^{n} Q_S^i$$

$$(43)\quad P_S = \sum_{i=1}^{n} r_i\, P_S^i$$

$$(44)\quad P_D = \sum_{i=1}^{n} r_i\, P_D^i$$

The above equations show that the U.S. demand and supply functions are weighted averages of the demand and supply functions of the individual regions. Equations (41) and (42) show that the quantity dependent demand and supply functions are simple summations of the quantity dependent functions of each region.

The market prices for the individual regions combine through a weighted average to form the market price for the total U.S.;

$$(45)\quad P_M = \sum_{i=1}^{n} \left[r_i\, P_M^i \right]$$

In equation (45), P_M^i represents a solution to the simultaneous demand and supply system which characterizes the market for the commodity in region i.

The following definitions apply to the "measures of initial impact" of pesticide bans as measured for the individual regions.

$\left[\% \Delta P_S^i\right]_{Q=Q_M^i}$ This notation represents the percentage shift in supply price or permit cost function as a consequence of a pesticide ban. This percentage reflects an upward vertical shift of the supply function for the region. Notice that it is measured at the initial market quantity $Q = Q_M^i$.

$\left[\% \Delta Q_M^i\right]_{P=P_M^i}$ This percentage measures the extent of the leftward shift of the commodity supply function in region i. Note that the percentage is measured at $P=P_M^i$.

$\left[\% \Delta P_D^i\right]_{Q=Q_M^i}$ This percentage measures the extent of the vertical downward shift of the farm level demand in region i. This downward shift would occur because of quality reductions imposed by a pesticide ban. The percentage is measured at the initial market quantity

The measures of initial impact for the total U.S. would be expressed as weighted sums of the initial impacts measured for m affected regions. The three measures of initial impact for the total United States would be given by the following three equations:

$$(46) \qquad \left[\%\ \Delta P_S\right]_{Q=Q_M} = \sum_{i=1}^{m} \left[r_i \left(\%\Delta\ P_S^i\right)\right]_{Q=Q_M^i}$$

$$(47) \qquad \left[\%\ \Delta Q_S\right]_{P=P_M} = \sum_{i-1}^{m} \left[r_i \left(\%\Delta\ Q_S^i\right)\right]_{P=P_M^i}$$

$$(48) \qquad \left[\%\ \Delta P_D\right]_{Q=Q_M} = \sum_{i=1}^{m} \left[r_i \left(\%\Delta\ P_D\right)\right]_{Q=Q_M}$$

The formulas which permit the estimations of percentage change in market price would then take account of the difference in impact between regions:

$$(49) \qquad \%\Delta\ P_M = \left[\frac{\sum_{i=1}^{m} \left[r_i \left(\%\ \Delta\ P_S^i\right)\right]_{Q=Q_M^i}}{1 + \left(\frac{E_D}{E_D}\right)}\right]$$

Equation (49) is the formula that would be used to estimate the percentage change in market price that would result from increases in per unit cost of commodity production. The equation takes account of the different increases in per unit cost that occur in the various regions as a result of the pesticide cancellation.

Equation (50) is the formula that would be used to estimate the extent of a percentage change in market price resulting from yield reductions.

(50) $$\%\Delta P_M = \left[\frac{\sum_{i=1}^{m}\left[r_i \left(\% \; Q_S^i\right)\right]_{P=P_M^i}}{E_S + E_D}\right].$$

This equation allows for differences between regions in the yield reductions imposed by a pesticide cancellation.

The use of the formula in (51) below permits an estimate of the percentage change in price that would result from quality reductions:

(51) $$\% \; \Delta P_M = \left[\frac{\sum_{i=1}^{m}\left[r_i \left(\% \; \Delta \; P_D^i\right)\right]_{Q=Q_M^i}}{\left(\frac{E_S}{E_D}\right) + 1}\right]$$

This equation allows for differences in the extent of downward shift of the demand functions in the various regions. There would be expected differences between regions because the degree of quality reduction imposed by a pesticide ban would be expected to vary geographically.

Application of the Formulas with Available Data

The formulas derived in this analysis are designed to permit the estimation of percentage changes in the price of a commodity. However, before these formulas can be used, a determination must be made of the market price and quantity to be used as a base in the estimation of percentage changes. A practical and suggested approach to the determination of a base price and quantity is that of deriving an annual average for a period extending over a number of years. For

instance the base price to be used for a region could be given by the simple average,

$$(52) \qquad P_M^i = \left[\frac{\dfrac{\sum_{t=1}^{T} R_t^i}{T}}{\dfrac{\sum_{t=1}^{T} Q_t^i}{T}} \right] = \left[\frac{\sum_{t=1}^{T} R_t^i}{\sum_{t=1}^{T} Q_t^i} \right].$$

The following definitions apply to equation 67.

t = the time subscript indicating a particular year in a series of years (this subscript increments from 1)

T = the last in a series of years over which an average is calculated.

R_t^i = The total value of crop sales for the commodity in region 1 in year t.

Q_t^i = The total quantity of the commodity produced and marketed in region i in year t.

It should be pointed out that T also represents the number of years in the period over which the average is calculated. This point is apparent from the fact that t increments from 1.

The base price to be used as a surrogate or proxy market price for the U.S... would be given by the following equation:

$$(53) \qquad P_M = \sum_{i=1}^{n} \left(r_i \right) \left[\left[\frac{\sum_{t-1}^{T} R_t^i}{\sum_{t=1}^{T} Q_t^i} \right] \right] = \sum_{i=1}^{n} \left[r_i \; P_M^i \right] = \left[\frac{\sum_{t=1}^{T} R_t}{\sum_{t=1}^{T} Q_t} \right].$$

In this equation 'n' is the number of regions or states in the U.S.. The price P_M should be interpreted as an average market price for the entire U.S.. It is a weighted average of the average market price for the respective regions or states. Certainly this average price, P_M, does not represent an equilbrium price in the strict sense of the word. However, it is assumed that the weighted sum is a reasonable good approximation of the market price of the commodity being analyzed.

The "market quantity" associated with the price P_M would be given by the following:

$$(54) \qquad Q_M = \sum_{i=1}^{n} Q_M^i .$$

The "market quantity" for the U.S., Q_M, is a sum of the "market quantities" of the individual regions. These latter quantities would be derived by averaging quantities produced and sold in the region over the period of T year in length.

$$(55) \qquad Q_M^i = \left[\frac{\sum_{t=1}^{T} Q_t^i}{T} \right]$$

The number of years used in the average would vary depending upon the type of commodity. The chosen number of years is a strictly judgemental consideration and will be based on one's experience with the market for the commodity.

Per Unit Price as An Estimate of Per Unit Production Cost

In many cases the effect of a pesticide cancellation will be an increase in per unit production cost. Equation 49 would thus be the formula employed to approximate the percentage change in the price of the commodity. This formula requires information on the percent change in per unit supply price. A particular base must be chosen in calculating the percentage. Per unit supply price is a measure of per unit production cost if all costs are included. Thus, in a situation in which information is readily available, the per unit production in each state would be used as the base in calculating the weighted average change in production cost for the U.S. as a whole. However information on production costs is frequently not available for many areas affected by a cancellation of a pesticide. Production budgets are frequently only available for small areas within a few states thus affected. Additional problems arise because of the incompatiblity between production budgets prepared in different states.

There is an alternative source of information which can provide estimate of average per unit production cost. The per unit price in each affected state will serve as a proxy estimate of per unit production cost. The use of this proxy is implied in the technique described above. The price P_M is assumed to be equal to both the demand price, P_D, and the per unit supply price (as represented by P_s). Since this equality is assumed to hold, P_M (as defined in (45) above) is used to define the initial value of market price and the

base to be used in defining average percentage changes in per unit cost for the U.S. as a whole.

The use of per unit price (average over a number of years) as a measure of per unit production cost is based on the fundamental assumption that the industry is in long run equilibrium. If a competitive industry is in long run equilibrium, average revenue per acre will be equal to average cost per acre and average price per unit of output is equal to average production cost per unit of output. There would be no incentive on the part of growers to expand or contract the production of the commodity. Also there would be no incentive on the part of "potential new" growers to enter the industry nor for existing growers to discontinue production. Certain corollary conditions must exist for an industry to be characterized by a long-run equilibrium. These would include the following:

(1) There must be a relatively large number of growers. This number would be large enough to prevent any one grower from affecting the price of the commodity.

(2) No one grower would be able to produce volumes of the commodity sufficient to affect the average U.S. market price.

(3) There must be no barriers which would impede the entry of growers into the industry.

(4) There must be a relatively free flow of information on costs and price such that growers can make informed decisions concerning exit or entry from the industry.

(5) The measure of costs used must include the returns to all resources involved in the production of the commodity. These costs would include the labor, land and materials necessary in the production process. However, the returns to managerial effort, entrepreneurial talent and the "risk return on capital" would also be included in the costs of production. The latter items would necessarily have to earn a competitive rate of return if the production of the commodity is to be sustained over an indefinite period of time.

(6) The adjustment to long run equilibrium of the industry would be characterized by the following conditions and processes:

(a) There would be no incentive for growers currently producing the commodity to expand or contract production. This condition would reflect the fact that average revenue is equal to average cost. If average revenue (price) were greater than average cost, there would be an incentive for growers to expand production. This expansion on the part of existing growers would lower the price and bid up the cost of inputs. Eventually price and average cost would be equal. If on the other hand, average revenue were less than average cost, there would be an incentive for producers to reduce production of the commodity. This reduction would increase the price of the commodity and "bid down" the costs of productive inputs. This adjustment would tend to bring average revenue and average cost back into equality.

(b) Returns to resources allocated to the production of alternative commodities must be roughly equal to the returns to resources used to produce the commodity affected by the pesticide cancellation. If the return to resources in alternative crops were to exceed that obtained in the production of the affected crop, there would be a shift of resources away from this latter crop to the alternatives. This shift would increase the price of the affected crop or commodity and lower the prices of the alternative crops. The supply of the farmer is reduced and that of the latter commodity expanded. At the same time, the prices of resources remaining in the production of the affected commodity would increase. This increase would increase average cost of production of the affected commodity. The prices of resources shifted into the production of alternative crops would be forced downward as productivity of these resources declines and as their availability increases for those production activities. This adjustment process would continue until average revenue and average cost are equal in the production of the commodity affected by the cancellation. Also, the returns to resources in alternative crops would be approximately equal to returns in the production of the affected commodity.

The conditions which must exist for an industry to be in long-run equilibrium are rather strict in nature and never fully exist in reality. Also the adjustment processes described above never come to completion

because constant changes which occur both within and outside the industry. However, the assumption of a long-run equilibrium permits the use of average U.S. price as an estimate of average U.S. production cost for a commodity. Such an estimate is particularly useful in attempts to determine the impacts on commodity price.

SECTION III.

A. CHRISTMAS TREE PLANTATIONS AND PINE NURSERIES
B. FLORAL
C. TURFGRASS
D. GRASS SEED

SUMMARY OF PRELIMINARY BENEFIT ANALYSIS

EBDC USE IN CHRISTMAS TREE PLANTATIONS AND PINE NURSERIES

A. USE: Red and Scotch pines (especially in Connecticut, Indiana, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Missouri, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Vermont, Washington, West Virginia, Wisconsin)

B. MAJOR PEST CONTROLLED: *Lophodermium pinastri* (pine needlecast disease)

C. ALTERNATIVES:

Major registered chemicals: Chlorothalonil

Non-chemical controls: Alternating blocks of species, sanitation measures

Efficacy of alternatives: Mancozeb has been shown to give 95% control, chlorothalonil 87%, in Christmas tree plantations. No efficacy data were found for nurseries. Non-chemical controls would lessen severity but not control the disease.

Comparative performance: A spreader-sticker is needed with the EBDC fungicides but not with chlorothalonil.

Comparative costs: Since application costs are identical, only chemical costs are presented here. These vary by region, level of disease, site treated. Per acre annual chemical cost ranges:

	mancozeb	chlorothalonil
Christmas trees		
East	\$14 - 18	\$28 - 38
PNW	22 - 40	44 - 84
Pine nurseries		
East	\$18 - 35	\$38 - 75
PNW	22 - 40	44 - 84

Conclusions: Chlorothalonil is less desirable because of its lower efficacy and higher costs.

D. EXTENT OF USE:

Quantity a.i.: Records available only for U. S. Forest Service and State of Washington. No estimates available for other nurseries or Christmas tree plantations because use varies depending on number of spores. Quantity could range from 80,000 to 114,000 lb. a.i. annually for Christmas trees.

Acres treated: Estimated 1050 acres of pine seedbeds in impact areas could need treatment. USDA estimates 10,000 acres of Christmas trees use mancozeb. No estimates available for chlorothalonil but use is reported by individual growers who alternate mancozeb with chlorothalonil to prevent resistance.

E. ECONOMIC IMPACTS:

User: Christmas tree impacts estimated to range from \$500,000 to \$587,000 annually (yield loss and added chemical cost). Nursery impacts of \$20,000 to \$42,000 annually, not including commercial nurseries.

Consumer: Christmas tree buyers may experience higher prices along with decreased supply of Scotch pine, presently the best-selling species.

F. SOCIAL/COMMUNITY IMPACTS: Minor disruptions in local job market may be felt if growers switch to *Lophodermium*-resistant species or to other geographic areas.

G. LIMITATIONS: Lack of complete data on extent of use, lack of production data for these industries by species, uncertainty about future levels of infection and need for control, uncertainty over grower plans and consumer responses to those plans.

H. PRINCIPAL ANALYST AND DATE:

Clara Roy, Natural Resource Economist
Economic Analysis Branch
Benefit and Field Studies Division
Office of Pesticide Programs
September, 1978

PRELIMINARY BENEFIT ANALYSIS OF THE USE OF EBDC FUNGICIDES IN CHRISTMAS TREE PLANTATIONS AND CONIFER NURSERIES

CURRENT USE ANALYSIS

EPA Registrations

Mancozeb (under the trade names "Dithane M-45" and "Manzate 200") is the only EBDC fungicide registered for control of *Lophodermium pinastri*, or pine needlecast disease. Chlorothalonil is the only other chemical registered for this disease. (Pelletier, 1978)

Use of Mancozeb and Alternatives

Records of usage in Christmas tree plantations are not available. Use of these fungicides in state, forest industry and commercial pine nurseries might occur wherever pine seedlings are produced, but this analysis is limited to those states where the disease is prevalent, i.e., Maine, Michigan, Minnesota, North Carolina, Pennsylvania, South Carolina, Washington, West Virginia, and Wisconsin. (Skilling, 1978a)

Quantity of Fungicide

Total usage for any given year is difficult to estimate because application rates and number of treatments vary by infection level and strain of the disease organism. Given the recommended rate and number of applications for moderate and heavy levels of infection,

annual usage in Christmas tree plantations could range from 80,000 to 114,000 lb a.i.

The U.S. Forest Service reported using 111 lb a.i. of chlorothalonil in FY 1977. The 55 lb a.i. of maneb reported used may or may not include mancozeb, since some confusion over the common name exists in the field. Both chemicals were reported for nursery use, but exact location and specific disease being controlled were not identified. (USDA-FS, 1978) The State of Washington reported using 40 pounds of mancozeb product in 1977 in their forest nursery near Olympia. (Russell, 1978a)

Acres Treated

USDA/State/EPA (1978) estimated that 10,000 acres of Christmas tree plantations in the impact area are treated annually (a possible 6% of all acres of Scotch and red pine). Actual acres of nursery seedbeds treated are unknown. Using the number of acres available in the impact area and estimates of the number of those used for pine seedling production, however, an estimate of acres possibly needing treatment annually can be derived (see Table III-1). This estimate of 1050 acres does not include commercial (non-forest) nurseries, since data on their use of mancozeb were not available.

PERFORMANCE EVALUATION OF MANCOZEB AND ALTERNATIVES

Pest Infestation and Damage

Lophodermium affects red and Scotch pines in nurseries and Christmas tree plantations, where close planting creates a microclimate

Table III-1

Acres Available for Forest Nursery Stock,
Estimated Acres of Pine Seedlings, and
Total Number of Pine Seedlings, by Affected State, 1975

State	Acres Available[a/]	Estimated Acres in Pine[b/]	Estimated Number of Pine Seedlings[c/] (millions)
ME	40	20	14
MI	218	160	112
MN	579	410	287
NC	158	40	28
PA	94	70	49
SC	224	60	42
WA	330	30	21
WV	145	100	70
WI	219	160	112
Total in Impact Area	2,007	1,050	735

a/ Bareroot and container operations, converted to acres (excluding most forest nurseries)
b/ Scotch and red pine only
c/ Assumes an average of 700,000 seedlings per acre available in Scotch and red pine

Source: Derived from USDA, 1976; Skilling, 1978.

favorable to the disease. Needles become discolored and fall off, hence the common name "needlecast disease."

Nurseries: Vigor is reduced, and stock may not recover from severe attacks, suffering high mortality. Some surviving stock may be too poorly formed to sell, and some marketable stock may be infected at time of shipping. This stock can provide the inoculum for later field infection. (Skilling, 1978b)

Christmas Trees: First disease symptoms in Christmas tree plantations commonly appear on only the lower part of the tree. As the disease intensifies, all needles except the current year's foliage die. If the needles do not fall off, the tree appears reddish brown. With or without the infected and dead needles, the tree is unmarketable.

Epidemics, affecting entire Christmas tree stands, can develop in two or three years. In nurseries, with dense foliage and moist conditions from irrigation, an epidemic can build in one season. (Nicholls and Skilling, 1974).

Geographic Variations

Winters in eastern and north-central states are usually cold enough to suppress the disease part of the year. Fungicide applications are limited to periods when the disease organism is active (July - September). In the Pacific Northwest (PNW), with mild wet winters, control is needed over a

longer time period. This situation is complicated by the existence of an additional species of this fungus, which thrives in the moist maritime climate. (Staley et al., undated)

Comparative Performance Evaluation

Comparative Efficacy

Mancozeb has been shown to give 95% disease-free control, compared to 87% control with chlorothalonil. (Staley and Harvey, 1973) Timing, frequency and rate of application are critical factors. Sanitation measures could enhance the efficacy of either fungicide (see Appendix III-A-1 for a list of recommended sanitation practices).

Comparative Costs

Tables III-2, 3, 6 and 7 develop total chemical costs per treatment and per year, by fungicide, infection level, use site and geographic region.

Chemical Costs: In both geographic regions, a pound of chlorothalonil is more than twice as expensive as a pound of mancozeb. Mancozeb ranges from $1.58 to $1.66 per pound of the 80% wettable powder formulation. Chlorothalonil is $3.75 for the 75% wettable powder formulation.

Per Acre Treatment Costs: Even allowing for the added cost of the surfactant needed with mancozeb, treatment of an acre with chlorothalonil costs more than twice as much as a per acre treatment with mancozeb. For example, chemical costs for an acre of Christmas

Table III-2

Per Acre Chemical Costs of *Lophodermium* Control in Christmas Tree Plantations, Eastern States, 1978

	Mancozeb	Chlorothalonil	
	(WP)	(WP)	(F)
Application rate (formulation)	2.5 lbs.	2.5 lbs	2.5 pts.
Chemical cost	$ 1.66 per lb.a/	$ 3.75 per lb.b/	$31.00 per gal.c/
Spreader-sticker	$ .44d/	– d/	– d/
Total chemical cost per treatment	$ 4.59	$ 9.38	$ 9.9[illegible]
Number of annual treatments			
moderate infection level	3	3	3
heavy infection level	4	4	4
Total annual chemical cost per treatment			
moderate infection level	$13.77	$28.14	$29.06
heavy infection level	$18.36	$37.52	$38.75

a/ Average 1978 price of mancozeb (Dithane M45 and Manzate 200) in New York and Ohio
b/ Average 1978 price of Bravo 75WP in New York and Ohio
c/ Average 1978 price of Daconil 2787 (6F) in New York and Ohio
d/ 4 oz. per acre (not needed with chlorothalonil); average 1978 price in New York and Ohio

Source: derived from Nicholls and Skilling, 1974.

Table III-3

Per Acre Chemical Costs of <u>Lophoderium</u>
Control in Christmas Tree Plantations, Pacific Northwest, 1978

	Mancozeb (WP)	Chlorothalonil (WP)	Chlorothalonil (F)
Application rate			
moderate infection level	2.5 lbs. a/	2.5 lbs. b/	2.5 pts. c/
heavy infection level	4.0 lbs.	4.0 lbs.	4.0 pts.
Chemical cost	$ 1.58 per lb. a/	$ 3.75 per lb. b/	$28.00 per gal. c/
Spreader-sticker	$ .39 d/	- e/	- e/
Total chemical cost per treatment			
moderate infection level	$ 4.34	$ 9.38	$ 8.75
heavy infection level	$ 6.71	$15.00	$14.00
Number of annual treatments			
moderate infection level	5	5	5
heavy infection level	6	6	6
Total annual chemical cost per treatment			
moderate infection level	$21.70	$46.88	$43.75
heavy infection level	$40.26	$90.00	$84.00

a/ Dithane M45, 50-lb. bag
b/ Bravo 75 WP
c/ Bravo 6F or Daconil 2787
d/ 4 oz. per acre, at $12.50 per gallon
e/ Not needed for chlorothalonil

trees in the Pacific Northwest are $4.34 with mancozeb (WP) and $9.38 with chlorothalonil (WP), assuming a moderate infection. Comparisons for other sites and infection levels lead to similar conclusions.

ECONOMIC IMPACT ANALYSIS

Profile of Impact Area

Christmas Trees

Most Christmas tree production is found in the Pacific Northwest and the states bordering the Great Lakes. For the most part, these are also the areas where *Lophodermium* is reported to be a problem (see Figure III-1).

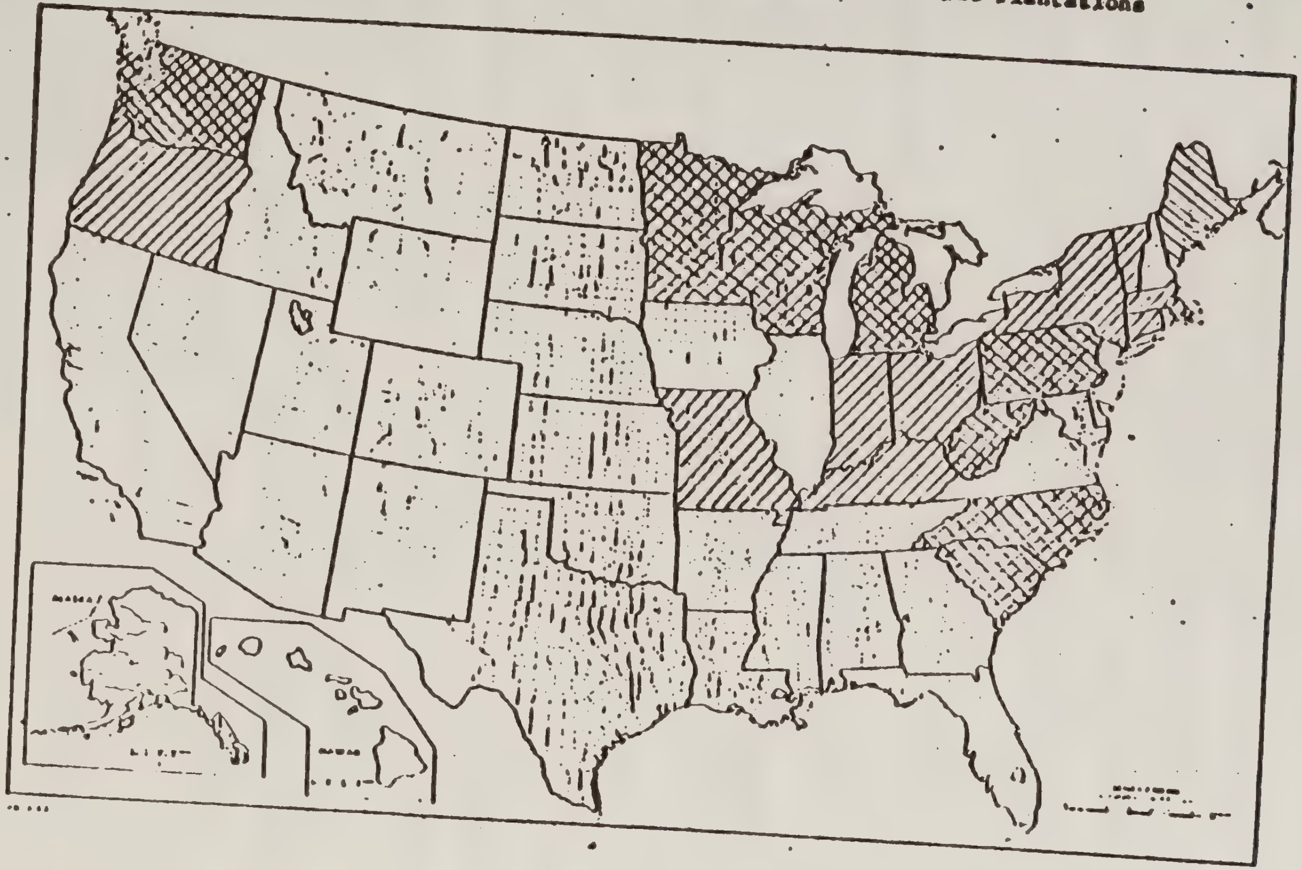
Nationwide, the majority of the trees sold (and therefore produced) has been Scotch pines. The length of time needed to produce a marketable pine is shorter than for other species such as spruce or Douglas fir, and pines can be grown on soil too poor for other species. Many growers now producing Scotch pines probably cannot switch to *Lophodermium*-resistant species, should mancozeb be cancelled for this use.

Nurseries

A number of commercial nurseries produce pine seedlings and transplants for sale to Christmas tree growers and to wholesalers for ornamental use. These are not included in this analysis because of lack of data on their use of mancozeb.

Figure III-1

Distribution of Lophodermium in Conifer Nurseries and Christmas Tree Plantations



States with significant levels of infection in Christmas tree plantations

States with significant levels of infection in nurseries

Source: Skilling, 1978

Stock produced in U.S. Forest Service nurseries are used almost exclusively for reforestation on National Forests. State nurseries, operated by state forestry agencies, produce seedlings mainly for reforestation of state and nonindustrial private forest land. Most also sell stock to Christmas tree growers and other state agencies, such as a highway department for use as windbreaks.

User Impacts

Christmas Trees

Annual chemical costs of using mancozeb and chlorothalonil in Christmas tree plantations are presented in Tables III-2 and -3. Since chlorothalonil has been shown to be less effective, yield loss is presented in Table III-4. Table III-5 sums the expected user impacts in Christmas tree plantations. Added costs of using chlorothalonil, if mancozeb is cancelled for this use, are estimated at half a million dollars - slightly less if the infection level is moderate, more if a heavy infection level develops.

In the long run, this impact could be softened by growers' plans to relocate or change to other species. Only large growers who own land in more than one region can choose the former option. Only growers with suitable land (e.g., soil composition, drainage, microclimate) can do the latter.

Nurseries

Tables III-6 and -7 derive the annual per acre chemical costs for mancozeb and chlorothalonil. Costs of controlling *Lophodermium*

Table III - 4

Value of Expected Yield Loss by Substituting Chlorothalonil for EBDC Fungicides to Control *Lophodermium* in Christmas Tree Plantations

	East	PNW	U.S.
Acres treated	9,000	1,000	10,000
Average yield per acre (trees)			
no disease[a/]	900	900	900
disease controlled by EBDC[b/]	855	855	855
disease controlled by Chlorothalonil[b/]	783	783	783
Added per acre yield loss using chlorothalonil (trees)	72	72	72
Average number of infected acres ready for harvest annually[c/]	1,125	143	1,268
Expected total yield loss annually (trees)	81,000	10,296	91,296
Value of expected annual loss[d/]	$291,600	$37,066	$328,666

a/ Assumes 1,000 trees per acre, 90% marketable

b/ Source: Staley and Harvey, 1973

c/ Total acres treated divided by average number of years in a rotation (7 years in PNW, 8 years in East)

d/ Assumes a price to te grower of $3.60 per tree sold (USDA/State/EPA, 1978)

Table III-5

Comparative Annual Treatment Costs Using Mancozeb and Chlorothalonil to Control *Lophodermium* in Christmas Tree Plantations, Number of Acres Treated, Total Impact (1978)

	East	PNW	U.S.
Per acre cost of using mancozeb			
moderate infection level	$13.77	$21.70	-
heavy infection level	$18.36	$40.26	-
Per acre cost of using chlorothalonil[a/]			
moderate infection level	$28.14	$43.75	-
heavy infection level	$37.52	$84.00	-
Per acre cost increase			
moderate infection level	$14.37	$22.05	-
heavy infection level	$19.16	$43.74	-
Number of acres treated	9,000	1,000	10,000
Total treatment cost increase			
moderate infection level	$129,330	$22,050	$151,380
heavy infection level	$172,440	$43,740	$216,180
Value of added annual yield loss[b/]	$291,600	$37,066	$328,666
Total annual impact			
moderate infection level	$420,930	$59,116	$480,046
heavy infection level	$464,040	$80,806	$544,846

a/ Least-cost formulation, from Tables III-2, III-3
b/ From Table III-4

Table III-6

Per Acre Chemical Costs of Lophodermium Control in Pine Nurseries, Eastern States, 1978

	Mancozeb	Chlorothalonil	
	(WP)	(WP)	(F)
Application rate (formulation)			
moderate infection level	2.5 lbs.	2.5 lbs.	2.5 pts.
heavy infection level	4.0 lbs.	4.0 lbs.	4.0 pts.
Chemical cost	$ 1.66 per lb.a/	$ 3.75 per lb.b/	$31.00 per gal.c/
Spreader-sticker	$ .44d/	-d/	-d/
Total chemical cost per treatment			
moderate infection level	$ 4.59	$ 9.38	$ 9.69
heavy infection level	$ 7.08	$15.00	$15.50
Number of annual treatments			
moderate infection level	4	4	4
heavy infection level	5	5	5
Total annual chemical cost per treatment			
moderate infection level	$18.36	$37.52	$38.75
heavy infection level	$35.40	$75.00	$77.50

a/ Average 1978 price of Dithane M45 and Manzate 200 in New York and Ohio
b/ Average price of Bravo 75WP in New York and Ohio
c/ Average 1978 price of Daconil 2787 (6F) in New York and Ohio
d/ 4 oz. per acre (not needed with chlorothalonil); average 1978 price in New York and Ohio

Source: derived from Nicholls and Skilling, 1974.

Table III-7

Per Acre Chemical Costs of Lophodermium Control in Pine Nurseries, Pacific Northwest, 1978

	Mancozeb	Chlorothalonil	
	(WP)	(WP)	(F)
Application rate (formulation)			
moderate infection level	2.5 lbs.a/	2.5 lbs.b/	2.5 pts.c/
heavy infection level	4.0 lbs.	4.0 lbs.	4.0 pts.
Chemical cost	$ 1.58 per lb.a/	$ 3.75 per lb.b/	$28.00 per gal.c/
Spreader-sticker	$ .39d/	_e/	_e/
Total chemical cost per treatment			
moderate infection level	$ 4.34	$ 9.38	$ 8.75
heavy infection level	$ 6.71	15.00	$14.00
Number of annual treatments			
moderate infection level	5	5	5
heavy infection level	6	6	6
Total annual chemical cost per treatment			
moderate infection level	$21.70	$46.88	$43.75
heavy infection level	$40.26	$90.00	$84.00

a/ Dithane M45, 50-lb. bag
b/ Bravo 75 WP
c/ Bravo 6F or Daconil 2787
d/ 4 oz. per acre, at $12.50 per gallon
e/ Not needed for chlorothalonil

Source: derived from Nicholls and Skilling, 1974, and Russell, 1978.

in forest nurseries, if the EBDC fungicides are cancelled, are estimated to increase by $20,000 to $42,000 annually, depending on the level of infection. (Table III-8)

This estimate does not include commercial nurseries, nor does it take yield loss into account. Control is critical in a nursery, because the disease can be transported to all parts of the United States on stock that appears healthy. The level of infection experienced in Christmas tree stands is in part determined by the level of control obtained in nurseries. It is possible, therefore, that if disease symptoms are discovered on some seedlings, the nursery manager may refuse to sell (or be forbidden to sell) the entire seedbed (as has happened more than once in Michigan as a result of quarantine regulations). (Skilling, 1978 b) Using an average of 700,000 seedlings per acre and a seedling market price of $63 per thousand (Russell, 1978a and 1978b), this loss is estimated at $44,100 per acre.

Because added yield loss due to chlorothalonil's lower efficacy is expected to be randomly located throughout the pine seedbeds, the nursery manager could be faced with an outbreak in every bed. To avoid this, the nursery would probably use more chlorothalonil treatments than were used in this analysis. Disease control might stay the same as under mancozeb but at an added cost of more than the $20,000 to $42,000 total estimated above.

Table III-8

Comparative Annual Treatment Costs Using Mancozeb and Chlorothalonil to Control *Lophodermium* in Pine Nurseries, Number of Acres Treated, Estimated Annual Impact (1978)

	East	PNW	U.S.
Per acre cost of using mancozeb			
moderate infection level	$18.36	$21.70	-
heavy infection level	$35.40	40.26	-
Per acre cost using chlorothalonil[a/]			
moderate infection level	$37.52	$43.75	-
heavy infection level	$75.00	$84.00	-
Per acre cost increase			
moderate infection level	$19.16	$22.05	-
heavy infection level	$39.60	$43.74	-
Estimated number of acres treated[b/]	1,020	30	1,050
Total estimated treatment cost increase			
moderate infection level	$19,543	$ 662	$20,205
heavy infection level	$40,392	$1,312	$41,704

a/ Least-cost formulation from Tables III-6 and III-7
b/ From Table III-1

Market Impacts

This was not investigated because of uncertainties of Christmas tree growers' plans should registration of mancozeb be cancelled. Reforestation efforts in the Lake states would certainly suffer, but impacts would not be felt immediately.

Consumer Impacts

Nursery customers would probably note a price increase and decreased supply of Scotch and red pines almost immediately, with the shortage preceding a price increase in public nurseries, if production falls significantly. Seedling prices of other species would be expected to rise because of increased demand. (It should be noted that the shortages of Scotch pine already have been reported for 1979 and 1980 nursery stock.)

Christmas tree buyers might not experience any impact for a few years. Prices might rise in the short run because of shortages due to yield loss, but since growers are generally price takers, and price elasticity of Christmas trees is unknown, this consumer price increase cannot be quantified.

Social/Community Impacts

Some impact on seasonal jobs might be felt if Christmas tree growers shift production to other parts of the country or to other species which require less labor (e.g., for shearing). This impact cannot be determined, but it is estimated to be minor.

Limitations of the Analysis

1. Extent of use of specific fungicides for <u>Lophodermium</u> control in state, forest industry and commercial pine nurseries and in Christmas tree plantations could not be determined or quantified without a survey.
2. Projections for future need for mancozeb in order to determine short-run impacts could not be made with existing resources because of the many factors involved, such as fluctuations in infection levels.
3. Consumer impacts could not be quantified because of lack of information needed to make a market projection.
4. Specific impacts in nurseries could not be quantified accurately because of varying state policies on sale of stock from nurseries experiencing <u>Lophodermium</u> infections.

SOURCES CONSULTED

Nicholls, Thomas H. and Darroll D. Skilling. 1974. Control of Lophodermium Needlecast Disease in Nurseries and Christmas Tree Plantation. USDA Forest Service Research Paper NC-110. North Central Forest Experiment Station. St. Paul, Minnesota.

Pelletier, E. Neil, Plant Pathologist. 1978. EBDC Use Profile for Economic Analysis - EBDC Fungicides. Plant Sciences Branch, BFSD, OPP, EPA. Washington, D.C. 14 August.

Russell, Kenelm W., Forest Pathologist. 1978a. State of Washington Department of Natural Resources. Olympia. Personal Communication. 27 June.

______________. 1978b. State of Washington Department of Natural Resources. Olympia. Personal Communication. 23 October.

Staley, John M. and George Harvey. 1973. Report for Fiscal Year 1973: Cooperative Study of Lophodermium Pinastri and Other Related Factors Affecting Production of Quality Scotch Pine Christmas Trees. FS-RM and PNW 2301. Fort Collins, Colorado. 20 June.

Staley, John, Gerry Raymond, George Harvey, Robert Deskins, Arlen Davidson and Ken Russell. Undated. Control of Lophodermium Needle Cast in Pacific Northwestern Scot's Pine. USDA Forest Service, Rocky Mountain Forest and Range Experiement Station. Fort Collins, Colorado.

Skilling, Darroll D., Principal Plant Pathologist. 1978a. USDA Forest Service, North Central Forest Experiment Station. Personal Communication. St. Paul, Minnesota. 6 September.

______________. 1978b. USDA Forest Service, North Central Forest Experiement Station. St. Paul, Minnesota. Personal Communication. 20 October.

USDA, Forest Service. 1976. A Directory of Forest Tree Nurseries in the United States. Washington, D.C. July.

USDA, Forest Service. 1978. Pesticide Use Report for FY 1977. Forest Insect and Disease Management. Washington, D.C.

USDA/State/EPA Assessment Team. 1978. Assessment of Ethylenebisdithiocarbamate (EBDC) Fungicide Uses in Agriculture (Draft). Part II. An Analysis of Current EBDC Uses; Their Benefit, the Role of Alternatives, and Impacts to Agriculture from Changes in EBDC Use Patterns. Washington, D.C. April.

APPENDIX III-A-1

Sanitation and Cultural Practices Recommended to Supplement Fungicide Application in Controlling *Lophodermium*

1. Avoid prolonged moist periods in nurseries. During the irrigation season, water early in the day.

2. Avoid using the same species in windbreaks. If nursery stock or Christmas tree stand is Scotch pine, windbreak should be a resistant species such as true fir, white pine, spruce, Douglas fir, cedar, poplar, etc.

3. Do not ship infected seedlings, transplants or trees. The disease can be carried to new areas this way.

4. Plant only healthy seedlings or transplants. If any are suspected of being diseased, have them checked before outplanting.

5. Alternate blocks of species. Plant a few rows of Scotch pine, then a few rows of some resistant species.

6. Choose the more resistant, long-needled Scoth pine.

7. Clean up litter after harvest.

Source: Nicholls and Skilling, 1974; Russell, 1978b.

Introduction

Fungal problems on floral crops are most prevalent in warm humid climates such as those in the southeastern States. In 1970, the value of cut flowers, florist greens, potted, bedding or other florist plants produced in the U.S. was $485 million (4). The 15 southeastern States had production valued at $117 million or 24 percent of the U.S. total. California's production in 1970 was valued at $107 million (22 percent of the U.S. total), followed by Florida at $65 million (13 percent of the U.S. total).

The protection value of the EBDC fungicides can be seen from an analysis of their importance in the production of chrysanthemums and gladioli in Florida. Florida is used as representative of the need for the EDBC fungicide in the southeastern States and was chosen because of the availability of data and the sizeable impact on the Florida floral industry.

The restriction of the economic analysis to two floral crops in Florida should not be interpreted to mean that the EBDC fungicides are not important on other floral crops in Florida or in other States. For example, only zineb (an EBDC) an two copper fungicides are registered for use on roses in Florida. Of the 354 zineb products registered, 58 contain general recommendations for use on roses. Zineb is considered to be of major importance for both private and commercial production of roses (1). However, cost data were not available to enable an economic analysis to be conducted for zineb.

The wholesale value of chrysanthemums, both cut floral and potted, for Florida averaged $17.8 million during 1975-76 (Table III-9). The total U.S. wholesale value was $109 million. The wholesale value of gladioli in Florida for the same 2 years averaged $11.4 million. The U.S. total gladioli value was approximately $17 million.

Current EBDC Use

EBDC's are used on a large number of ornamentals as was stated in the Biological Assessment: mancozeb is registered for use on 21 hosts, maneb for 16 hosts, and zineb for 21 hosts (1). The specific fungal diseases they are used against are also numerous: mancozeb 26 diseases, maneb 35 diseases, and zineb 69 diseases. This widespread efficacy makes them particularly useful to growers, especially growers who specialized in a variety of crops in regions where numerous fungal diseases are prevalent. It is also important during portions of the growing season when immediate action against a number of fungal diseases is necessary, such as after unexpected warm rains.

The cost savings realized through a smaller inventory and the reduced planning time with only a single fungicide as opposed to numerous ones is impossible to determine. It is dependent upon the size of operation, the cultivars grown, and the pathogens expected. Due to the variety of possible floral uses for each EBDC, it is impossible to work backward from the amount of EBDC available for application and arrive at a value of the plants which are protected or the cost of the alternative chemicals necessary to replace them.

The EBDC fungicides insure the grower of a means of adequate, non-phytotoxic control over a wide variety of virulent fungi which greatly reduces the uncertainty of his income, irrespective of climatic conditions. The economic impact of having a fungicide which is not phytotoxic has also not been calculated. This quality allows immediate use up to the time of harvest.

The economic analysis will center upon two specific floral crops, chrysanthemums and gladioli, in a warm, humid climate where outdoor growing conditions could result in a total loss due to disease without protective fungicides.

The analysis for chrysanthemums is divided into floral and stock production. Floral production is the growing of flowers for sale on the wholesale market. Stock production is the production of plants which will be marketed to other nurseries across the nation; these other nurseries will then produce the flowers.

Assumptions

Chrysanthemums, floral, Florida

1. Protective fungicides are applied weekly on 900 acres. (A crop is not in the ground all weeks of the year but during the season of most prevalent fungal action the applications are made more often than weekly)

2. Mancozeb is applied every other week, alternating with either benomyl or chlorothalonil. Application costs are the same.

3. If mancozeb was not available, it would be replaced by applications

of chlorothalonil or benomyl without any loss in production. Phytotoxicity of chlorothalonil limits its ability to replace EBDC.

Chrysanthemums, stock, Florida

1. Applications of protective fungicides for stock production are made more often than for floral production and are estimated to be 70 applications of mancozeb, 25 chlorothalonil, 8 benomyl per growing season over a land area of 130 acres (1).

2. Without mancozeb, all of the mancozeb sprayings would be replaced by applications of chlorothalonil or benomyl without any loss in production.

3. Application costs are the same for mancozeb and the alternatives.

Gladioli, floral, Florida

1. On 8,100 acres of production, 26 applications of mancozeb are made every other week alternating with applications of either benomyl and ferbam.

2. Without mancozeb, all of the mancozeb sprayings would be replaced with sprayings of benomyl or ferbam without any loss in production.

3. Application costs are the same for mancozeb and the alternatives.

Results

User Impact

Because it was assumed that the alternative fungicides were as effective as mancozeb there would be no loss in production if mancozeb use is cancelled. The impact on growers in this analysis will therefore be restricted to changes in production costs.

Current disease control costs on the 900 acres of chrysanthemums grown in Florida for flowers is estimated at $335,000 (Table III-10). If the EBDC fungicides are cancelled, disease control costs are estimated to be $486,000 an increase of $151,000 over the present program or $168 more per acre than the current program.

On the 130 acres of chrysanthemums grown for stock production in Florida, current disease control costs with the EBDC fungicides available are estimated to be $79,000 or $606 per acre (Table III-11). Without the EBDC fungicides available, disease control costs are estimated at $139,000 or $1,070 per acre. The cancellation of the EBDC fungicides would increase growers' total disease control costs by $60,000 or $464 per acre.

Gladioli are grown for flowers on 8,100 acres in Florida. The cost of the current disease control program is estimated at $790,000 and is expected to increase by $146,000 if the EBDC fungicides are cancelled (Table III-12). On a per acre basis, disease control costs are expected to increase $18 without the EBDC fungicides.

The added costs of disease control are expected to be borne by the growers. A possible exception is the chrysanthemum stock trade where Florida growers supply a large portion of the national market.

No acreage shifts between floral crops were estimated. It is expected that some shifts may take place to other floral crops within the nursery. However, it is doubtful if new growers will enter the market because of the large capital investment necessary for the formation of a nursery.

Consumer Impact

The impact of an EBDC cancellation on consumer prices was not estimated because of the lack of data and the nature of the retail market. Consumer substitution between floral crops is not known but expected to be substantial. In floral chrysanthemum and gladioli production, the large growers are in competition with many local growers at the point of retail sale and are assumed to be in a competitive price market. There is also substantial foreign competition, especially from Central and South America. An increase in cost of chrysanthemum stock to other growers is expected. However, it is difficult to ascertain what effect this might have on the retail floral market.

Sources Consulted

1. USDA/State/EPA Assessment Team. 1978. Assessment of EBDC Fungicide Uses in Agriculture, Washington, D. C., September.

2. Seymour, C. P. 1977. Personal correspondence, Chief Plant Pathologist, Florida Department of Agriculture, November 16.

3. USDA, Marketing Research Reports Nos. 526, 951, 972, 1005, and 1042.

4. USDA, ERS. 1974. Ornamentals: Production and Marketing Trends, 1948-72, Statistical Bulletin No. 529, Washington, D. C., May.

5. Powell, C. 1978. Personal correspondence.

6. USDA. 1977. Agricultural Statistics 1977, Washington, D. C.

7. Horticultural Research Institute Research Summaries; Scope III of the Nursery Industry 1973, 1977, 1968; Operative Cost Study 1976 Landscape - 1976 retail.

Table III-9. Floral crops in Florida: Gross wholesale sales value for chrysanthemums and gladioli, and U.S. total, data for 1975-76 average a/

Item	Chrysanthemums						Gladioli	
	Standard		Pompom		Potted			
	Wholesale value	Percent of U.S.	Wholesale value	Percent of U.S.	Wholesale value	Percent of U.S.	Wholesale value	Percent of U.S.
	$1,000	percent	$1,000	percent	$1,000	percent	$1,000	percent
Florida	1,244	4.3	10,128	31.0	6,447	13.6	11,388	66.3
Total U.S.	29,241		32,625		47,552		17,183	

a/ Data from Agricultural Statistics 1977, USDA, Washington, D. C., Table 382, page 267.

Table III-10. Chrysanthemums: Grown in Florida for flowers, present disease control program and possible alternative control program if use of the EBDC fungicides is cancelled a/

Condition and fungicide	Acres grown	Number of applications per year	Acre treatments	Pounds a.i. per application	Total pounds of fungicide applied	Cost per pound a.i.	Control cost: Total	Control cost: Per acre
							dollars	
Present								
Mancozeb	900	26	23,400	3.0	70,200	1.25	87,750	
Chlorothalonil	900	18	16,200	3.0	48,600	3.30	160,380	
Benomyl	900	8	7,200	2.0	14,400	6.00	86,400	
							334,530	372
Without EBDC								
Chlorothalonil	900	40	36,000	3.0	108,000	3.30	356,400	
Benomyl	900	12	10,800	2.0	21,600	6.00	129,600	
							486,000	540
					Expected cost difference		151,470	168

a/ Based on information in "Assessment of EBDC Fungicide Uses in Agriculture", USDA/State/EPA Assessment Team, September 1978.

Table III-11. Chrysanthemums: Grown in Florida for stock, present disease control program and possible alternative control program if use of the EBDC fungicides is cancelled a/

Condition and fungicide	Acres grown	Number of applications per year	Acre treatments	Pounds a.i. per application	Total pounds of fungicide applied	Cost per pound a.i.	Control cost: Total	Control cost: Per acre
							dollars	
Present								
Mancozeb	130	70	9,100	3.0	27,300	1.25	34,125	
Chlorothalonil	130	25	3,250	3.0	9,750	3.30	34,125	
Benomyl	130	8	1,040	2.0	2,080	6.00	12,480	
							78,780	606
Without EBDC								
Chlorothalonil	130	79	10,270	3.0	30,810	3.30	101,673	
Benomyl	130	24	3,120	2.0	6,240	6.00	37,440	
							139,113	1,070
					Expected cost difference		60,333	464

a/ Based on information in "Assessment of EBDC Fungicide Uses in Agriculture", USDA/State/EPA Assessment Team, September 1978.

Table III-12. Gladiolus: Grown in Florida for flowers, present disease control program and possible alternative control program if use of the EBDC fungicides is cancelled a/

Condition and fungicide	Acres grown	Number of applications per year	Acre treatments	Pounds a.i. per application	Total pounds of fungicide applied	Cost per pound a.i.	Control cost: Total	Control cost: Per acre
								dollars
Present								
Mancozeb	8,100	26	210,600	3.0	631,800	1.25	789,750	98
Without EBDC								
Benomyl	8,100	8	64,800	2.0	129,600	6.00	388,800	
Ferbam	8,100	18	145,800	3.0	437,400	1.08	546,750	
							935,550	116
Expected cost difference							145,800	18

a/ Based on information in "Assessment of EBDC Fungicide Uses in Agriculture", USDA/State/EPA Assessment Team, September 1978.

TURFGRASS

Introduction

The major use of the EBDC fungicides on turfgrass is against diseases caused by _Helminthosporium_, _Rhizoctonia_ and _Pythium_. Almost every turfgrass species is attacked by _Helminthosporium_. _Rhizoctonia_, causative agent of brown patch, is more prevalent in the humid areas of the Southeast, East and Midwest. _Pythium_ is especially virulent upon bentgrass and rye grasses and is perhaps the most severe of the pathogens because, under ideal conditions, it spreads over very large areas.

Assumptions and Procedures

1. The actual area (1,000 square feet) treated with EBDC fungicides is not known. It was assumed that an applicable measure for comparative purposes would be the area which could be treated if each 1,000 sq. ft. is given only one application at the standard use rate. Some areas, however, may be treated as many as 10 times. For this study the total amount of EBDC fungicides used annually was divided by the standard treatment per 1,000 sq. ft. to obtain the treated area.
2. The amount of the three EDBC's, maneb, zineb, and mancozeb, available for use was estimated by Assessment Team based on information supplied by industry source.
3. The distribution of the pounds of each of the EBDC's for use on each of the major pathogens was estimated by the Assessment

Team based on their knowledge and contacts with other pathologists in the field.

4. The alternative fungicide would be applied at rates which would make them equally effective to the EBDC°s in controlling the diseases.
5. The numbers of applications for the EBDC fungicides and the alternatives were assumed to be the same.
6. The alternative fungicides were specified by the Assessment Team based on efficacy and treatment cost per 1,000 sq. ft.

Current Use

Very little data is available concerning actual application. The lack of data is due to the large number and wide variety of users, their wide geographical dispersion, and the intermittence of use. Some fungicidal applications are made intermittently with fertilizer application (such as home use), other applications are made to limit spread after the disease has been noted, and still others are applied routinely on a strict schedule such as on golf course greens.

The estimated amount of EBDC used on turfgrass was supplied by industry. A total of approximately 516,000 pounds of EBDC°s is estimated to be used annually; maneb (311,000 pounds) zineb, (22,500 pounds) and mancozeb (183,000 pounds) (Table III-13). The distribution of the EBDC fungicide use by disease was made by the Assessment Team. Maneb use was estimated at: 70 percent for Helminthosporium, 10 percent for Rhizoctonia, and 20 percent for Pythium. Mancozeb use was estimated at: 60 percent for Helminthosporium, 10 percent for Rhizoctonia, and 30 percent for Phythium. Zineb, a minor use, was estimated to be split equally between control of Helminthosporium and Pythium. Control of other turfgrass diseases also

occurs when EBDC applications are made.

Alternative Control

The alternative controls selected in each case were the least cost alternatives. Alternatives, as effective as the EBDC fungicides existed in all cases. The alternatives were also assumed to be available in adequate amounts and at current prices. All of the alternatives are listed in Table III-15

Results

The EBDC fungicides are estimated to be used on 2.0 billion sq. ft. of turfgrass annually at a total cost of about $945,000 (Table III-14). About $614,000 are spent annually to control Helminthosporium on 1.3 billion sq. ft. of turfgrass. Pythium is the second most important disease with 530 million sq. ft. of turfgrass treated at an annual cost of $242,000. An estimated 171 million sq. ft. of turfgrass are treated annually for Rhizoctonia at a cost of $89,000. If the EBDC fungicides are cancelled, disease control costs could increase from $450,000 to $1.1 million depending which alternative fungicide is used (Table III-16). By disease the smallest economic impact would be in the control of Rhizoctonia where treatment costs would decrease $12,600 if cycloheximide + PCNB is used or increase about $9,600 if thiram is used. It should be noted that PCNB is currently undergoing RPAR review and may not be available for use as a replacement for the EBDC fungicides.

For Helminthosporium control the estimated range in the economic impact is from a decrease of $42,000 to an increase of $555,000. Again as with Rhizoctonia, the decrease in disease control costs is for cycloheximde + PCNB.

[illegible] applications and used

Alternative Control

alternative controls selected [illegible]

Alternatives, as effective as [illegible] EIS [illegible]

The alternatives may also include [illegible] available

and at current prices [illegible]

III-15

[illegible]

Fungicides [illegible] a estimated [illegible] [illegible]

annually at a total cost of about [illegible] (Table III-[illegible])

[illegible] are spent annually to control [illegible] [illegible] billion

[illegible]. [illegible] the second [illegible]

[illegible] sq. ft. of [illegible] treated [illegible] cost [illegible]

[illegible] 171 million sq. [illegible] are [illegible] annually [illegible]

[illegible] at a cost of [illegible]. [illegible] are [illegible]

[illegible] costs could increase from $250,000 to $1.1 million [illegible]

[illegible] fungicide [illegible] used (Table III-16). [illegible] the smallest

[illegible] would be in the [illegible] of [illegible] where [illegible]

[illegible] $12,600 [illegible]

[illegible] is used, it should be [illegible]

[illegible] and [illegible] available [illegible]

[illegible]

Intercropping control [illegible] economic

[illegible]

[illegible]

The greatest economic impact from the cancellation of the EBDC fungicides would be for *Pythium* control on 530 million sq. ft. of turfgrass with the impact ranging from $505,000 to $553,000 depending on alternative fungicide used.

Consumer impact

The importance of disease control in turfgrass culture has increased with the rising standard of living. Home lawns, athletic fields and golf courses have received special emphases in disease control. The increased cost of alternative fungicides make up such a small part of total turfgrass maintenance costs on these high value sites that restrictions on EBDC use would probably not affect the decision to use alternative fungicides for continued disease control.

Table III-13. EBDC use on turfgrass diseases, estimated annual use of maneb, mancozeb, and zineb for the major turfgrass diseases a/

Disease	Maneb	Mancozeb	Zineb	Total EBDC use disease
	(1,000 pounds a.i.)			
Helminthosporium	218	110	11.25	239.25
Rhizoctonia	31	18	—	49.00
Pythium	62	55	11.25	128.25
Total chemical used b/	311	183	22.50	516.50

a/ Poundage breakdown by disease supplied by the Assessment Team.

b/ Estimate of total fungicides used was supplied to the Assessment Team by industry.

Table III-14. Estimated chemical cost of EBDC application for each major turfgrass disease

Disease	EDBC	Estimated annual use a/	Application rate per 1,000 ft.^{2} b/	1,000 ft.^{2} treated annually c/	Material cost per Pound a.i. d/	Material cost per 1,000 ft.^{2} c/	Total Cost
		------ lbs. a.i. -------			------------ dollars	------------------	
Helminthosprium	Maneb	218,000	.15 - .40	778,571	1.60	.45	350,357
	Mancozeb	110,000	.20 - .40	366,667	2.20	.66	242,000
	Zineb	11,250	.09	125,000	1.92	.17	21,250
	Total	339,250	--	1,270,238	--	--	613,607
Rhizoctonia	Maneb	31,000	.15 - .40	110,714	1.60	.45	49,821
	Mancozeb	18,000	.20 - .40	60,000	2.20	.66	39,600
	Zineb	--	--	--	--		--
	Total	49,000	--	170,714	--	--	89,421
Pythium	Maneb	62,000	.15 - .40	221,429	1.60	.45	99,643
	Mancozeb	55,000	.20 - .40	183,333	2.20	.66	121,000
	Zineb	11,250	.09	125,000	1.92	.17	21,250
	Total	128,250	--	529,762	--	--	241,893
Grand total		516,500	--	1,970,714	--	--	944,921

a/ Table III-13.
b/ Specified by the Assessment Team based on product labels and State recommendations.
c/ Assumes average of application rates.
d/ Developed by the Assessment Team based on their knowledge of the fungicide market and manufacturers price lists

Table III-15. Treatment costs for the major alternative fungicides to EBDC for each turfgrass disease

Disease agent	Alternative fungicide	Application rate per 1,000 ft.^{2} a/	Material cost per Pound a.i. b/	Material cost per 1,000 ft.^{2}
		--- Pounds -	------ Dollars	--------
Helminthosporium	Anilizine	.16	5.76	.92
	Chlorothalonil	.19	4.69	.89
	Cycloheximide-PCNB c/	.09	4.96	.45
Rhizoctonia	Benomyl	.06	19.52	1.17
	Cycloheximide-PCNB c/	.09	4.96	.45
	Thiophanate methyl	.06	12.69	.76
	Anilizine	.16	5.76	.92
	Chlorothalonil	.19	4.69	.89
	Thiram	.21	2.77	.58
Pythium	Chloroneb	.16	9.35	1.50
	Terrazole	.19	21.12	4.01
	Feraminosulf	.11	12.80	1.41

a/ Specified by the Assessment Team based on product labels and State recommendations

b/ Developed by the Assessment Team based on their knowledge of the fungicide market and manufacturers price lists.

c/ In terms of formulated production because of the a.i. combination

Sources Consulted

1. USDA/State/EPA Assessment. 1978. Assessment of EBDC Fungicide Uses in Agriculture, Washington, D.C. September.

2. Cole, Herb. 1978. Personal communication.

3. EPA. 1978. EBDC Use Profile for Economic Analysis, OPP, BFSD, Plant Studies Branch, Washington, D.C. August.

Introduction

The major production region for turfgrass and other grass seed is Washington and Oregon. It is estimated that 270,000 acres of grass seed production fields were maintained in Washington and Oregon in 1977. During that year 50,000 acres of bluegrasses and ryegrasses were sprayed with maneb and maneb plus nickel sulfate fungicides for control of stem rust, strip rust, leaf rust and other foliar diseases.

In addition to losses in the seed fields, certain diseases such as *Helminthosporium* leaf spots may be transmitted by grass seed to new planting. It is well accepted that control of diseases in seed production fields is a sound commercial practice that minimizes the necessity for future control of seed-borne disease in the newly established planting. In this manner fungicide use in seed fields may result in lesser total fungicide use than if the planting were established with diseased seed or seeds bearing pathogen propagules (1).

In the past cultural control of disease was accomplished by the burning of residual straw, stubble and debris after harvest. This practice is being eliminated through legislation regarding air pollution. As long as burning is allowed the necessity of a chemical fungal treatment is questionable.

Assumptions and Procedures

1. Two or four sprayings per season of maneb are necessary at a rate of 1.6 to 2.4 pounds (a.i.) per acre. Maneb sells at $1.28 per pound (a.i.)

2. Grass yields were estimated by the Assessment Team to be 400-1,000 pounds per acre with maneb treatment. Without maneb treatment, yields were estimated at 100-300 pounds per acre.
3. The average wholesale price of grass seed is 40 cents per pound. The average cost of production is $170.00 per acre. Treatment chemical costs range from $4.08 - $12.28 per acre.

Alternative Control

1. Chemical control:
   a. State labels (24c - special local needs) for nickel sulfate, not considered as effective and is highly soluble.
   b. Possible future use of Bayleton®, experimental fungicide that has a use permit for 750 acres. Apparently effective, the chemical has not been fully tested.
2. Cultural control: In some areas burning still exists as a legal cultural control; this alternative is being eliminated.

Results

If average maneb treatment production is assumed to be 700 pounds per acre, the value of the crop would be $280 per acre and net returns per acre would be $110. The total estimated value of the treated Washington-Oregon crop is estimated to be $14.0 million.

Without maneb the total revenue per acre would fall to $40 - 120/acre (100 to 300 pounds x 40 cents) and be insufficient to cover average production costs of $170.00 per acre.

Production of some non-resistant cultivars would be eliminated. Acreage would shift out of production, or to areas allowing burning.

Sources Consulted

1. USDA/State/EPA Assessment Team, Assessment of EDBC Fungicide Uses in Agriculture, Washington, D.C., September 1978.

SECTION IV.

A. PEANUTS
B. TOBACCO
C. WILD RICE
D. SMALL GRAINS

SUMMARY OF ECONOMIC IMPACT ANALYSIS OF CANCELLING
EBDC USE ON PEANUTS

A. USE: EBDC use on commercial peanut production.

B. MAJOR DISEASES CONTROLLED: Leafspot caused by cercospora personata and cercosporidum arachidas.

C. ALTERNATIVES:

Major registered chemicals: Chlorothalonil (preferred), Benomyl, Captafol, Dodine, Triphentin, Copper, and Sulfur.

State Recommendations:

	Number of States Recommending for Cercospera Leaf Spot
EBDC	10
Benomyl	8
Chlorothalonil	11
Captafol	5
Dodine	1
Triphentin	11
Copper	10
Sulfur	6
No alternatives recommended	0

Non-chemical controls: Adequate non-chemical control methods are not available.

Efficacy of alternatives: The preferred alternative, chlorothalonil, would provide disease control comparable to EBDC on those acres now being treated with EBDC.

Comparative performance: Yields and quality would remain the same in the near term with use of chlorothalonil in place of EBDC. Removing EBDC poses the possibility of resistance developing to alternative chemicals.

Comparative Costs: Season average chemical costs would rise from $15.96/acre to $26.60/acre or a difference of $10.64/acre if chlorothalonil were substituted for EBDC. It is assumed the number of applications would remain at six per season.

Conclusion: Registered, recommended, and effective alternative (chlorothalonil) is available although chemical cost will increase slightly. Removing EBDC raises possibility of resistance developing to alternatives now effective. The extent and timing of resistance development is not known.

D. EXTENT OF USE:

Active ingredient basis: Approximately 2.3 million pounds (active ingredient) EBDC divided among Texas(1,000,000 pounds), North Carolina (546,000 pounds), Oklahoma (400,000 pounds), and Virginia (336,000 pounds) were applied in 1977.

Acres treated basis: Approximately 273,000 acres were treated in 1977 with EBDC. These acres were divided among Texas (120,000 acres), North Carolina (65,000 acres), Oklahoma (48,000 acres), and Virginia (40,000 acres). Treated acres represent about 40% of harvested acres in the 4 states. Overall 14.4% of U.S. peanut production is treated with EBDC.

E. ECONOMIC IMPACTS:

User: Fungicide cost and hence production costs would increase by $10.64/acre ($2.9 million on all acres now treated with EBDC). In relative terms production costs would rise 2.9-4.3% on acres now treated. Net returns should remain sufficiently high to keep present EBDC users from shifting to crops other than peanuts if normal growing conditions occur.

Market: Production, cropping patterns, quality, and prices would not be significantly impacted in any of the peanut producing areas.

Consumer: No significant impacts.

Macroeconomic: No significant impacts.

F. SOCIAL/COMMUNITY IMPACTS: Not investigated because of the small economic impacts expected.

G. LIMITATIONS OF ANALYSIS: Usage survey data were not available. Assessment team members supplied estimates of EBDC usage.

Chlorothalonil is assumed to be available in sufficient quantities to replace EBDC at current prices.

H. PRINCIPAL ANALYST AND DATE:

John Bratland, USDA
Gary Ballard, EPA
September, 1978

PEANUTS

Introduction

This analysis will present an assessment of the economic impact of cancelling EBDC fungicide use on peanuts in the United States.

Peanuts are grown in about 10 States. However, there are 7 major producing States including: Alabama, Florida, Georgia, North Carolina, Oklahoma, Texas, and Virginia.

An EBDC cancellation would affect 4 of these States: Texas and Oklahoma in the Southern Plains, and North Carolina and Virginia in the mid-Atlantic region. About 40 percent of the peanut acreage in these States is treated with an EBDC fungicide (Table IV-1). These States account for 37 percent of total U.S. peanuts production. The EBDC fungicides are not used to any important degree in the other States.

Assumptions and Procedures

The economic assessment of the impact of an EBDC cancellation on the peanut industry was based on the following assumptions and procedures:

1. The EBDC fungicides are used to control two leafspot diseases: Cercospora personata and Cercosporidium personatum ~~arachidas~~.

2. The 1975-1977 average planted peanut acreage and production was used as the base for the analysis.

3. The acres treated with the EBDC fungicides were estimated by the Assessment Team. These estimates were based on their knowledge of the

industry, personal communication with colleagues, and published and unpublished material.

4. The EBDC fungicides (maneb and mancozeb) are applied at a rate of 1.4 pound active ingredient per acre, per treatment.

5. All acres currently treated with EBDC fungicides would be treated with the preferred alternative, chlorothalonil, at a rate of 1.25 pints (6 pounds (a.i.) per gallon) per acre, per treatment.

6. The number of applications were assumed to be the same for the EBDC and chlorothalonil at 6 treatments annually.

7. There would be no loss in yield per acre because the alternatives are as efficacious as the EBDC fungicides.

8. The price of chlorothalonil would not change significantly and would be available in sufficient quantities to replace the EBDC fungicides on the affected acreage.

Disease Control Program

The EBDC fungicides, though they are important in disease control in peanut crops, represent only one of a number of possible alternatives that could be used. The fungicides that could be used for the control of leafspot would include benomyl, chlorothalonil, captafol, dodine, triphentin, copper, and sulphur. These fungicides are not uniformly effective in control of the major diseases that affect peanuts. For instance, benomyl is less effective than other alternatives because the leafspot diseases quickly develop resistance to this fungicide.

In terms of disease control, it appears that the possible cancellation of the EBDC fungicides would not have a major impact on the peanut industry. There would not be any immediate inability on the part of farmers to control the two major diseases that attack peanut crops. Rather, the importance of EBDC fungicides, in respect to their alternatives, is more long-run in nature. EBDC fungicides, when used in rotation programs along with other fungicides, can help reduce the possibility of "building up a tolerant or resistent status of pathogens" (1).

Results

User Impact

The cancellation of the EBDC fungicides for use in peanut production would impact on production costs. Growers are currently spending an estimated $15.96 per acre for the EBDC fungicides to control leafspot diseases (Table IV-2). If use of the EBDC fungicides is cancelled and growers replace it with chlorothalonil, disease control costs are estimated at $26.60 per acre, per season, an increase of $10.64 over the EBDC fungicides.

The total impact of an EBDC cancellation in the 4 affected peanut producing States is estimated at $2.9 million (Table IV-3). The largest impact would occur in Texas with growers costs increasing an estimated $1.3 million.

Per-acre grower returns would be affected by the cancellation of the EBDC fungicides (Table IV-4). Returns to land and management currently

range from $310 per acre in Virginia to $81 per acre in Texas. The cancellation of the EBDC fungicides would increase growers' costs $11 per acre. This would cause a reduction in growers' return to land and management per acre of 14 percent in Texas and about 5 percent in the other States.

The decrease in grower returns might affect some marginal producers in Texas but it is very doubtful if growers in other areas would shift out of peanut production.

<u>Consumer Impact</u>

No significant reduction in peanut production would occur because of a possible cancellation of EBDC fungicides. There would be virtually no change in the quality of the commodity after an EBDC cancellation in the short-run. The average change in production cost would be less than one percent for total U.S. production. Any resulting decline in production would be small and would not warrant concern.

No significant increase in the price of peanuts would be expected from a cancellation of EBDC use on this crop. Thus, any negative welfare impact on consumers would probably be too small to measure.

Sources Consulted

1. USDA/State/EPA Assessment Team. 1978. Assessment of EBDC Fungicide Uses in Agriculture, Washington, D. C. September.

2. USDA, ESCS. 1978. Crop Production 1977 Annual Summary, CrPr 2-1(78), Washington, D. C., January.

3. Lamm, R. McFall. 1978. Personal communications. Commodity Economics Division, ESCS, USDA.

4. U.S. Senate, Committee on Agriculture and Forestry. 1978. Costs of Producing Selected Crops in the United States: 1976, 1977, and Projections for 1978.

Table IV-1. Average peanut acreage and production for 1975-77 and estimated acres treated annually with EBDC fungicides

States	Average acres treated 1975-77 a/	Percent acres treated with EBDC 1977 b/	Expected annual acres treated with EBDC	Average annual production 1975-77 b/	Percent of U.S. total production
				1,000 lbs.	
North Carolina	168,000	38.7	65,016	415,352	11.0
Virginia	104,000	38.7	40,248	293,060	7.8
Oklahoma	124,667	38.7	48,246	248,600	6.6
Texas	209,000	38.7	119,583	437,842	11.6
U.S. Total	705,667		273,093	1,394,854	37.0

a/ Crop Production 1977 Annual Summary, Crop Reporting Board, ESCS, USDA.

b/ Assessment of EBDC Fungicide Use in Agriculture, USDA/State/EPA Assessment Team, Washington, D. C., September 1978.

Table IV-2. Treatment cost per acre for EBDC and chlorothalonil, the most likely replacement if EBDC use in cancelled on peanuts

State	Average number of applications per acre per season a/	EBDC use per acre: Pounds (a.i.) per application a/	EBDC use per acre: Total (a.i.) per season	EBDC use per acre: Cost per season b/	Chlorothalonil use per acre: Total (a.i.) per season c/	Chlorothalonil use per acre: Cost per season d/	Increase in cost per acre withou EBDC
North Carolina	6	1.4	8.4	15.96	5.6	26.60	10.64
Virginia	6	1.4	8.4	15.96	5.6	26.60	10.64
Oklahoma	6	1.4	8.4	15.96	5.6	26.60	10.64
Texas	6	1.4	8.4	15.96	5.6	26.60	10.64

a/ Assessment of EBDC Fungicide Use in Agriculture, USDA/State/EPA Assessment Team, Washington, D. C., September 1978. It was assumed that the number of applications would be the same for EBDC and the alternative.

b/ The estimated average price for EBDC fungicides is \$1.90 per pound (a.i.). This price was derived from several current price lists.

c/ Chlorothalonil was specified by the Assessment Team as the preferred alternative to EBDC. It is applied at a rate of 1.25 pints (6 pounds (a.i.) per gallon) per acre per treatment.

d/ The price of chlorothalonil is estimated to be \$4.75 per pound (a.i.). This price was derived from several current price lists.

Table IV-3. Estimated total increase in production costs if EBDC fungicides are cancelled for use on peanuts

State	Acres treated with EBDC a/	Increase in disease control costs without EBDC	
		Per acre b/	Total
		dollars	$1,000
North Carolina	65,016	10.64	692
Virginia	40,248	10.64	428
Oklahoma	48,246	10.64	513
Texas	119,583	10.64	1,272
Total	273,093	10.64	2,905

a/ Table IV-1.

b/ Table IV-2.

Table IV-4. Per acre returns to land and management with and without EBDC fungicides for disease control on peanuts in selected States

Per acre	North Carolina	Virginia	Oklahoma	Texas
Yield in pounds a/	2,472	2,818	1,994	1,417
Gross revenue b/	494	564	399	283
Production costs c/	254	254	202	202
Returns to land and management with EBDC available	240	310	197	81
Increase in production costs without EBDC fungicides d/	11	11	11	11
Returns to land and management after an EBDC cancellation	229	299	186	70
Percent reduction in returns to land and management without EBDC	5	4	6	14

a/ Average yield for 1975-77. Crop Production 1977 Annual Summary, USDA, ESCS, CrPr 2-1(78), January 1978.

b/ Based on an average price of 20 cents per pound for 1975-77. Field Crops, Production, Disposition, and Value 1975-77 and 1976-77, USDA, ESCS, CrPr 1(77), May 1977 and CrPr 1(78), April 1978.

c/ Average costs for 1975-77. Costs of Producing Selected Crops in the United States, 1975, 1976 and Projections for 1977 and Costs of Producing Selected Crops in the United States, 1976, 1977 and Projections for 1978. Both studies were prepared by ESCS, USDA for the Committee on Agriculture and Forestry of the U.S. Senate. The first was published January 21, 1977 and the second was published March 31, 1978.

d/ Table IV-2.

SUMMARY OF PRELIMINARY BENEFIT ANALYSIS

A. USE: EBDC's/Tobacco (flue-cured, burley, and Maryland)

B. MAJOR PESTS CONTROLLED: anthracnose, blue mold, damping off

C. ALTERNATIVES:

Major registered chemicals: RPAR: EBDC's (zineb, maneb, and metiram)
NON-RPAR: ferbam, streptomycin

State/Federal recommendations:

Chemical	No. of States recommending
EBDC's	8
ferbam	8
streptomycin (blue mold only)	3

Non-chemical controls: Blue mold can be partially eliminated by growing plants under plastic and rotating bed sites.

Efficacy of alternatives and comparative performance: Growers can obtain control with one EBDC application weekly. One or two ferbam applications are required for similar control (except Maryland tobacco). Streptomycin is effective for blue mold control in only some parts of the country (Maryland).

Comparative costs: The total treatment cost/season for two applications of zineb, maneb, metiram, and streptomycin are $1.30, $1.04, $1.16 and $1.60, respectively. The total treatment cost for 2-4 applications of ferbam is $1.30-$2.60.

Conclusion: Ferbam and streptomycin may require more material and a greater number of applications to achieve control comparable to EBDC's. One or two applications of ferbam are required for comparable control.

D. EXTENT OF USE:

Type	Estimated total seedbed area	Estimated total seedbed area treated with EBDC's	Percent of total	Estimated pounds applied	Estimated growers or units treating
	-- mil. sq. yards --		- percent -	-lbs. a.i.-	- no. -
flue-cured	54.7	24.4-31.0	44.7-56.8	23,600-29,600	42,900-45,400
burley and Maryland	31.2	1.2-1.5	4.0-4.7	1,054-1,160	3,200

E. ECONOMIC IMPACTS:

User: The estimated change in total treatment costs to flue-cured and burley tobacco growers ranges between $28,100 and $337,200. No change in yield is foreseen. Costs of production and revenues to Maryland tobacco growers will decline 1.13-1.15 million dollars. Some Maryland tobacco growers may reduce production following years of significant disease losses.

Market: The market impacts on burley and flue-cured tobacco are expected to be negligible without EBDC's. Supply reductions of Maryland tobacco may result in years following significant disease losses; however, the extent and magnitude are unknown.

Consumer: No consumer impacts are expected.

Macroeconomic: No macroeconomic impacts are expected.

F. SOCIAL/COMMUNITY IMPACTS: No social or community impacts are foreseen.

G. LIMITATIONS OF ANALYSES: Current state recommendations are lacking in some cases. Little data are available on the quantity used, the number of users or other appropriate economic measures.

H. PRINCIPAL ANALYST AND DATE:

Gary S. Becker
Economic Analysis Branch
Benefits and Field Studies Division
Office of Pesticide Programs
October, 1978

CURRENT USE ANALYSIS

EBDC's (zineb, maneb, and metiram) are EPA registered, state recommended, and used as preventative controls for anthracnose, blue mold, and damping off in Florida, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and Maryland (Arnett; 1978, Burgess, 1978; Collins, 1978; Kittrell, 1978; Jones, 1978; McKee, 1978a; Todd, 1978; Whitty, 1978). No data are available regarding the use of these fungicides in other tobacco producing states. Alternative chemicals used for prevention of these diseases include ferbam and streptomycim (blue mold only).

Non-chemical controls are recommended in many of the aforementioned states. Blue mold control may be achieved by rotating the bed site every year (University of Florida, 1978). Tobacco plants grown under plastic are not as susceptible to blue mold as those produced under cloth (due to warmer temperatures) (Arnett, 1978; University of Georgia, 1967). There are no other non-chemical alternatives effective for the control of anthracnose, blue mold, and damping off.

In 1978, there were 54,684,000 square yards of flue-cured tobacco seedbeds in the United States. North Carolina, the largest flue-cured tobacco producer, accounted for approximately 34,000,000 square yards or 62.2 percent of the total (Todd, 1978). The next largest flue-cured tobacco producing state, South Carolina, accounted for 12.4 percent or 6,800,000 square yards of seedbed. Georgia and Virginia follow with 6,500,000 square yards (11.9 percent) and 6,100,000 square yards (11.1 percent) of the total, respectively. The smallest flue-cured tobacco producing states, Florida and Alabama, accounted for less than five percent of the U. S. total (See Table 1)1/.

In 1978, there were 31,150,000 square yards of burley and Maryland tobacco seedbeds in the United States. Kentucky, the largest burley tobacco producing state, accounted for approximately 64 percent or 20,000,000 square yards of the total (Atkinson, 1978). Maryland and Virginia growers accounted for 1,500,000 square yards and 1,070,000 square yards, respectively (McKee, 1978; Link, 1978). The remaining burley tobacco producing states accounted for approximately 8.5 million square yards or 27.5 percent (See Table 1).

1/ Based upon information provided by Whitty, 1978 and Todd, 1978. The estimated seedbed areas for Georgia, South Carolina, Virginia, and Alabama are determined by multiplying 1977 acreage harvested by 100 square yards of seedbed /acre.

Table 1
Industry Profile of Flue-cured, Burley, and Maryland Tobacco Producing States, 1977-1978.

Type	State a/	Seedbed area b/	Allotments or no. of growers c/
flue-cured (Types 11-14)		Square yards	No.
	FL	1,226,000	1,541
	GA	6,500,000	6,635
	NC	34,000,000	55,573
	SC	6,800,000	10,072
	VA	6,100,000	10,067
	AL	58,000	58
	TOTAL	54,684,000	83,946
burley and Maryland (Types 31 and 32)			
	KY	20,000,000	120,000
	MD	1,500,000	3,000 +
	VA	1,070,000	14,520
	Other States	8,580,000	118,648
	TOTAL	31,150,000	257,097 +

a/ Other burley tobacco producing states are Indiana, Missouri, North Carolina, Ohio, Tennessee, and West Virginia.

b/ Based on information provided by Whitty, 1978; Todd 1978; Atkinson, 1978; and McKee, 1978. The estimated seedbed areas for Georgia, South Carolina, Virginia and other states are determined by multiplying 1977 acreage harvested (USDA, 1978b) by 100 square yards of plant bed/acre.

c/ (USDA, 1977; Tarzy, 1978) 1977 flue-cured and burley allotments are adjusted to include those growers who requested ASCS officers to transfer allotments to other growers. This does not include individuals who leased land and allotments. Based upon the assumption that every flue-cured and burley tobacco grower leased all of his allotment as of June 14, 1977, and August 14, 1977, respectively.

EPA estimated that 24.4 to 31.0 million square yards (44.7 to 56.8 percent) of flue-cured tobacco seedbeds (54.7 million square yards total) were treated with EBDC's in 1977. Between 42,900 - 45,400 growers and/or allotments used 23.6-29.6 thousand pounds of the chemical. EBDC's are used most extensively on North Carolina and Virginia flue-cured tobacco. Approximately 22.4 to 27.2 million squares yards of North Carolina flue-cured tobacco were treated with 20.5 - 24.9 thousand pounds a.i. of EBDC's (maneb, metiram and zineb; 85.4 percent of total poundage used on flue-cured tobacco) by approximately 40,000 growers during 1977. About 2,000 flue-cured tobacco growers in Virginia accounted for 9.8 percent or 2,013 pounds a.i. of the chemical's use. The other flue-cured tobacco producing states using EBDC's (Florida, Georgia, and South Carolina) accounted for less than five percent of the total pounds applied. No data are available regarding the chemical's use in Alabama (See Table 2).

Significantly smaller quantities of EBDC's are used on burley and Maryland tobacco (compared to flue-cured). An estimated 280,000 square yards of Kentucky burley tobacco were treated with 567 pounds a.i. (maneb; 51.2 percent of total poundage used on burley and Maryland tobacco) of EBDC's during 1977 (Atkinson, 1978). Approximately 750 Maryland tobacco growers accounted for 423-529 lbs. a.i. of the chemical's use on 900,000 - 1,125,000 square yards of seedbed during average years of anthracnose infection (McKee, 1978a). In 1978, 1,125,000 square yards of plant bed were treated in Maryland (McKee, 1978a). Fungicide use by Virginia burley growers is almost non-existent and most Ohio growers use ferbam for disease outbreaks (Link, 1978; Wells, 1978). No data are available identifying the use of EBDC's in other tobacco producing states (See Table 2).

Table 2

Summary of EBDC Usage Data on Flue-cured, Burley, and Maryland Tobacco in the United States, 1977

Type	State	Estimated seedbed treated with EBDC's a/		Estimated pounds applied b/	Estimated growers or units treating c/	
		Sq. yards	Percent	Pounds (a.i.)	Percent	No.
flue-cured (Types 11-14)						
	FL	110,340	9.0	112	0.4	117
	GA	650,000-812,500	10.0-12.5	366-457	1.5	746
	NC	22,440,000-27,200,000	66.0-80.0 d/	20,503-24,897	85.4	40,000
	SC	0-1,700,000	0-25.0	0-1,566	2.9	0-2,518
	VA	1,220,000	20.0	2,606	9.8	2,013
	AL	ND	ND	ND	ND	ND
TOTAL		24,420,340-31,042,840	44.7-56.8	23,587-29,638	100	42,876 45,394
burley (Types 31 and 32)						
	KY	280,000	1.4	567	51.2	1,693
	MD	900,000-1,125,000	60.0-75.0	423-529	43.0	750
	VA	53,500	5.0	64	5.8	726
Other States		ND	ND	ND	ND	ND
TOTAL		1,233,500-1,458,000	4.0-4.7	1,054-1,160	100	3,169

ND - No data

a/ Based on information provided by : Whitty, 1978; Arnett, 1978; Todd, 1978; Jones, 1978; Atkinson, 1978; McKee, 1978a; and Link, 1978. Wells (1978) indicates that most Ohio growers use ferbam for disease outbreaks.

b/ Based upon the predominant formulation reported for each state (Whitty, Florida, zineb; Arnett, Georgia, maneb; Atkinson, Kentucky, zineb; and McKee, Maryland, maneb). In all other tobacco producing states, it is assumed the each EBDC (maneb, metiram, and zineb) treats one-third of the total acreage.

c/ Based upon information provided by Whitty, 1978; Arnett, 1978; Collins, 1978a; Kittrell, 1978; Jones, 1978; Mckee, 1978a; and Link, 1978.

d/ It is estimated that 25 percent of the total seedbed acreage is treated with fungicides (Kittrell, 1978).

PERFORMANCE EVALUATION OF EBDC's AND ALTERNATIVES

Few tests have been conducted comparing EBDC's with their alternatives. Information provided by Todd (1978) indicates that growers can obtain effective control applying EBDC's once a week. One or two ferbam applications are required for similar control.[1/] McKee (1978a) indicates that under normal conditions five percent yield losses are expected on Maryland tobacco using EBDC alternatives. Streptomycin is also an alternative but does not control anthracnose and damping off. In some parts of the country (Florida, North Carolina) streptomycin has been effective in eradicating blue mold, but in other parts of the country (Maryland) it has not been effective. Collins, 1978a; McKee, 1978a; Todd, 1978; Whitty, 1978).

ECONOMIC IMPACT ANALYSIS

Zineb, maneb, and metiram are approximately $.25 to $.35 per pound more costly than ferbam. However, these EBDC's are approximately one fourth the per pound cost of streptomycin. Assuming two EBDC applications per season are equally as effective as 2-4 ferbam applications, the total treatment cost per 100 square yards is expected to increase $0 - $1.56. The application cost ($.50/100 square yards/treatment) accounts for the largest portion

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1/ Dr. Furney Todd, Professor of Plant Pathology, North Carolina State University, stated in his letter dated February 1, 1978 that, "Most growers have found that they can obtain control with one application each week of EBDC fungicides while two are required for those containing ferbam."

Mr. Leo Link, Southwest Virginia Research Station, indicates: "Growers using either ferbam of EBDC's (equal number of applications) will achieve equal control for blue mold" on burley tobacco.

On Maryland tobacco, losses are estimated to be 5 to 10 percent using EBDC alternatives in bad anthracnose years (McKee, 1978a).

It is assumed that yields will not decline in years of normal anthracnose, blue mold, and damping off infections if EBDC alternatives are used on flue-cured and burley tobacco. Yield losses of five percent are estimated on Maryland tobacco (McKee, 1978a).

of the total increase (see Table 3). Total costs of production/acre are expected to increase an average of .06 percent from \$1290.34 to \$1291.12.[1/] Total costs of producing burley tobacco/acre are even higher, therefore the expected percentage increase will be even less than 0.06 percent.

The estimated total change in (chemical and application) costs of production to flue-cured and burley tobacco growers (Florida, Georgia, Kentucky, North Carolina, South Carolina, and Virginia) ranges between \$28,100 and \$337,200. This estimate is highly dependent upon the increased number of ferbam applications required to achieve effective control with comparable performance assuming no change in output (see Table 4). Under normal conditions, five percent yield lossess are expected on Maryland tobacco using EBDC alternatives (McKee, 1978a). Given that 1975 through 1977 production averaged 27.23 millions pounds/year (1975-23,000 acres, 950 lbs./acre; 1976 23,000 acres, 1,300 lbs/acre; 1977-23,000

1/ Based upon a 1977 North Carolina flue-cured tobacco production budget for a 25 acre farm. Total costs of production are defined as total operating cost, total interest charge, total ownership cost, and labor cost.

2/ Based upon a 1977 North Carolina burley tobacco production budget. The total cost of production/acre of burley tobacco is \$2,200.54.

Table 3
COMPARATIVE COSTS of EBDC's and ALTERNATIVES
in the FLUE-CURED, BURLEY, and MARYLAND TOBACCO PRODUCING
STATES of the U.S., 1978

Chemical and/or formulation	Chemical cost/lb formulation a/	Chemical cost 100 sq. yards	Application cost/ 100 sq. yards b/	No. of applic. c/	Total treatm cost, seaso
	dollars			No.	dolla
Zineb (Dithane Z-78; 75% WP)	1.65	.15	.50	2	1.30
Metiram (Polyram 80% WP)	1.57	.08	.50	2	1.16
Maneb (80% WP)	1.50	.02	.50	2	1.04
Ferbam (Fermate 76% WP)	1.25	.15	.50	2-4	1.30-2
Streptomycin (Agristrep)	6.00	.30	.50	2	1.60

a/ Based upon:

Ferbam (fermate 76% WP); $1.25/lb. formulation; Joe Burke, Cardinal Chemical Company; 1978.
Zineb (Dithane Z-78); $1.65/lb. formulation; Joe Burke, Cardinal Chemical Company; 1978.
Metiram (Polyram 80% WP); $1.57/lb. formulation FMC Corporation, Agricultural Chemicals Division; 1978.
Maneb (Maneb 80% WP); $1.50/lb. formulation; McKee, University of Maryland; 1978.
Agristrep; $6.00/lb. formulation; Cardinal Chemical Company; 1978.

b/ Application cost/100 square yards is based on data provided by Dr. William K. Colli North Carolina State University at Raleigh.

c/ No. of applications based upon information provided by Dr. William O. Atkinson, University of Kentucky; Dr. William K. Collins, N.C. State University; and Dr. Clau McKee, University of Maryland.

Table 4

Economic Impact to Tobacco Growers Using EBDC Alternatives for Fungi Control in the Southeastern United States as Estimated for 1977-1978

Type	State	EBDC treatments a/	Ferbam treatments b/	Chemical and application cost/100 square yards using EBDC's c/	Chemical and application cost/100 square yards using Ferbam	Change in chemical and application cost/100 square yards	Estimated seedbed area treated with EBDC's d/	Total change in treatment cost/season
		— Avg. No./Season —		——— dollars ———			— Square yards —	— dollars —
Flue-cured (Types 11-14)								
	FL	3.0	3.0 - 6.0	1.95	1.95 - 3.90	0 - 1.95	110,340	0 - 2,152
	GA	3.0	3.0 - 6.0	1.56	1.95 - 3.90	.39 - 2.34	650,000 - 812,500	2,535 - 19,013
	NC	1.5	1.5 - 3.0	0.88	0.98 - 1.95	.10 - 1.07	22,440,000 - 27,200,000	22,440 - 291,040
	SC	1.5	1.5 - 3.0	0.88	0.98 - 1.95	.10 - 1.07	0 - 1,700,000	0 - 18,190
	VA	3.5	3.5	2.03	2.28	0.25	1,220,000	3,050
	AL	ND	ND	ND	ND	ND	ND	ND
	TOTAL	1.63	1.63 - 3.11	.95	1.06 - 2.02	.11 - 1.07	24,420,340 - 31,042,840	28,025 - 333,445
Burley and Maryland (Types 31 and 32)								
	KY	2.0	2.0 - 4.0	1.30	1.30 - 2.60	0 - 1.30	280,000	0 - 3,640
	MD	2.5	2.5 - 5.0	1.30	1.63 - 3.25	0.33 - 1.95	900,000 - 1,125,000	2,970 - 21,938
	VA	2.0	2.0	1.17	1.30	0.13	53,500	70
	Other States	ND	ND	ND	ND	ND	ND	ND
	TOTAL	2.38	2.38 - 4.67	1.30	1.55 - 3.05	.25 - 1.75	1,233,500 - 1,458,500	3,040 - 25,648

a/ The average number of EBDC treatments/season are derived from: Whitty, 1978; Collins, 1978; Jones, 1978; Atkinson, 1978; and McKee, 1978a. Data are not available from Georgia and South Carolina, therefore, the average number of applications in Florida, and North Carolina, respectively and used as a proxy. In Virginia, Link (1978) indicates that growers using either ferbam or EBDC's (equal number of applications) will achieve equal control for blue mold. The number of EBDC applications in Kentucky is assumed to be the same as Virginia. (Information is not available on the yield or quality impact resulting from anthrachose or damping off.)

b/ Except for Virginia, it is assumed that twice as many applications are required for effective control. McKee (1978a) indicated that growers using ferbam in Maryland will incur reduced yields.

c/ Based upon zineb and maneb use in Florida and Georgia respectively, (Whitty, 1978; Arnett, 1978) on flue-cured tobacco. Atkinson (1978) and McKee (1978a), indicate zineb and maneb are used more often than other EBDC's in Kentucky and Maryland, respectively. In North Carolina, South Carolina, and Virginia, the average chemical cost of zineb, maneb, and metiram are used in calculating the chemical cost per application.

acres, 1,300 lbs/acre) with 75 percent of the beds treated, then total supply is expected to decline 1.02 million pounds to 26.21 million pounds/year.1/

Gross revenue to Maryland tobacco growers is expected to decline $65.49/acre as a result of the yield impact.2/ Multiplied by the total acreage treated with EBDC's (17,250 acres), gross revenue will decline $1.13 million or an average of $1,506 to each of the 750 growers using EBDC's. The estimated total change in income due to increased costs of production and reduced revenues to Maryland tobacco growers is approximately 1.14 million dollars ($1,132,673-$1,151,641).

Total supply of Maryland tobacco, (resulting from a yield effect) is expected to be less the first year following a potential EBDC cancellation. Until the average price per pound is high enough (such that growers transfer acreage from other crops to produce tobacco), Maryland tobacco growers will not increase their acreage.3/ It is not known whether acreage will increase in subsequent years since the Maryland tobacco production budget indicates that the per pound of production (all costs plus $15,000 for operators labor and management) is $1.39.4/ The 1977 average price per pound of Maryland tobacco was $1.15. Growers should

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1/ Yield data are not available on EBDC and non-EBDC treated acreage. For this analysis, the average three-year total production and yield figure for all Maryland tobacco are used as a proxy for EBDC treated acreage.

2/ The average yield/acre (1975-1977) was 1,183 lbs./acre. 1,183 lbs./acre - .95 = 1,124 lbs./acre, 1,183 lbs./acre - 1,124 lbs./ acre = 59 lbs./acre. 59 lbs./acre x $1.11/lb. = $65.49/acre.

3/ Assumes that all crop acreage is fully utilized.

4/ University of Maryland - Maryland tobacco budget, prepared by George Stevens. Defined to include all costs of production/ acre for a 50 acre specialized tobacco farm plus $15,000 for operators labor and management. The average three-year yield (1,183 lbs./acre) for Maryland tobacco in the 1975-77 is used in calculating the cost per pound of production.

continue current production as long as total gross revenue is greater than or equal to average variable costs per acre.

While the overall number of ferbam applications per acre is expected to increase on flue-cured tobacco, the market impacts are expected to be slight without EBDC's. The price support program and market quota system are two institutional elements complementing each other to adjust production of flue-cured tobacco and to assure adequate economic returns to growers. No unexpected change in demand is forseen since the additional people of smoking age and the heavy promotion of low tar, low nicotine brands have offset the dampening of cigarette smoking due to the anti-smoking campaign.

If more pesticide material is required and the cost of control increases (additional applications on flue-cured tobacco), the tobacco price support program will not reflect the total increase in production costs during the first year of an EBDC cancellation. The tobacco price support program using a three-year average parity index formula, means price support rise more slowly during periods of rapid input price increases. Any increases in costs of production will only be partially reflected during the first year following a cancellation. Not until three years after a cancellation will costs of production be fully reflected in the support price.

The market impacts resulting from burley tobacco growers replacing EBDC's with ferbam are expected to be neglible . The average total cost of production per acre to all burley growers will not change significantly ($\leq$ \$1.30/acre). As shown in Tables 2 and 4, very few growers are cureently using EBDC's on burley tobacco. Supply, which is influenced by the price support program and market quota system, will not be greatly affected if EBDC's becomes unavailable.

Maryland tobacco growers have not approved marketing quotas since the 1965 crop; therefore, Maryland tobacco has not been eligible for government price supports. Assuming the overall economic risks of growing Maryland tobacco are greater than the risks and uncertainty of growing flue-cured or burley tobacco, significant disease losses may cause some growers to cease or reduce production (McKee, 1978a). However, the extent and magnitude are unknown.

Other reasons why market and consumer impacts are not expected to be significant are: first, cigarette consumption per capita in 1977 for individuals 18 years and older was 4.064 pieces or 7.07 pounds (203 packs of 20) (USDA, 1978). Therefore, each pack contains approximately .035 pounds or 4.1 cents (assuming the value of tobacco is 117.6 cents/pound. In August, 1977 the wholesale

price of one pack of cigarettes was $0.22. Adding in the Federal Excise tax (8 cents) and the state cigarette taxes (13 cents; weighed by the number of packs taxed), the average value of a pack of cigarette is $0.43 (USDA, 1978). Since 10 percent of the value of a pack of cigarettes is the tobacco, only significant increases in the value of tobacco would have an impact on the consumer level if EBDC's become unavailable. Secondly, studies indicate that: cigarette consumption in any given year is heavily determined by consumption in the previous year largely characterized by habitual use and therefore, targeted output is largely geared to consumption rather than vice versa (Miller, 1974). No macroeconomic, social, and/or community impacts are expected.

LIMITATIONS AND ASSUMPTIONS

Many limitations and assumptions exist within this analysis. Those which follow are considered most important. Little test data are available on comparative efficacy and performance of EBDC's and alternatives. The number of users, non-users, and pounds, a.i. applied were estimated. The reported rates of application are significantly different from state to state and cannot be satisfactorily documented. In some cases, current state recomendations were not always obtainable. Economic related data such as acres treated, number of treatments, and yield information are lacking from all the tobacco producing states.. This analysis relies on the expertise and best available information provided by knowledgeable individuals in their respective states. Average infections of blue mold, anthracnose, and damping off are assumed. In some cases, EBDC's have not been disaggregated into their respective formulations (maneb, zineb, and metiram) while in other cases they have. Finally, growers replacing EBDC's with ferbam are assumed to have adequate supplies of the alternative chemical.

SOURCES CONSULTED

Arnett, James. 1978. University of Georgia Experiment Station. Rural Development Center. Tifton. Personal Communication. 29 August.

Atkinson, William O., Res. Spec. Tob. Prod. and Mgt. 1978. University of Kentucky. Personal Communication. 15 August.

Burgess, Gene and Hunter, Phil. 1978 Tobacco Pest Control, Sp 91. University of Tennessee, Agricultural Extension Service. January.

Burke, Joe. Cardinal Chemical Company. North Carolina. 1978. Personal Communication. 17 August.

Clemson University. Cooperative Extension Service. 1976. South Carolina Tobacco Recommendations for 1977. Clemson, South Carolina. December.

Clemson University. Cooperative Extension Service. 1978 The 1978 Agricultural Chemicals Handbook. Clemson, South Carolina.

Collins, W. K., Agronomy Specialist (Tobacco). 1978. North Carolina State University. Personal Communication. 25 July.

Collins, W.K., Agronomy Specialist (Tobacco). 1978a. North Carolina State University. Personal Communication. 16 August.

FMC Corporation, Agricultural Chemicals Division. 1978. Midland, Michigan, Price List. Personal Communication. 17 August.

University of Florida, Florida Cooperative Extension Service, IFAS. 1978. Disease Control Program for Flue-cured Tobacco, Extension Plant Pathology Report No. 23. Gainesville. 9 January.

University of Georgia, Cooperative Extension Service. 1967. Disease Control in Tobacco Plant Beds, Leaflet No. 19. Athens. December.

Jones, James L., Assistant Professor, Tobacco. 1978. Virginia Polytechnic Institute and State University. Blacksburg. Personal Communication. 30 August.

University of Kentucky, Department of Plant Pathology. 1964. No. 4 Blue Mold of Tobacco. Lexington. May.

University of Kentucky, Department of Plant Pathology. 1967. No. 2 (revised) Tobacco Anthracnose. Lexington. April.

Kittrell, Ben. 1978 Pee Dee Experiment Station. Florence, South Carolina. Personal Communication. 23 August.

[illegible]

[illegible] University of [illegible]

[illegible]

[illegible]

[illegible] University [illegible]

[illegible] University [illegible]

[illegible] State University, [illegible]

[illegible]

[illegible] University of Florida, [illegible]

[illegible] Tobacco Plant [illegible]

[illegible] Assistant Professor [illegible] Institute and State University [illegible] 30 August.

[illegible] of Kentucky, Department of Plant Pathology [illegible] of Tobacco. Lexington, Ky.

[illegible] of Kentucky, Department of Plant Pathology [illegible] Tobacco [illegible] Lexington [illegible]

[illegible] Experiment Station [illegible] Personal [illegible] 27 August.

Link, Leo, Research Associate in Plant Physiology. 1978. Southeast Virginia Research Station. Glade Spring. Personal Communication. 21 August.

McKee, Claude G., Maryland Tobacco Improvement Foundation, Inc. 1978 Handbook on the Culture of Maryland Tobacco. Fifth Edition. Upper Marlboro, Maryland.

McKee, Claude G., Extension Tobacco Specialist. 1978a. University of Maryland Cooperative Extension Service. College Park. Personal Communication. 7 August.

Miller, Robert H. 1974. Factors Affecting Cigarette Consumption. (unpublished). New York. September.

North Carolina State University, North Carolina Agricultural Extension Service. 1977. 1978 Tobacco Information. Raleigh. December.

North Carolina State University, The School of Agriculture and Life Sciences. 1978 The North Carolina Agriculture Chemicals Manual. Raleigh. January.

The Americam Phytopathological Society. 1966. Fungicide - Nematocide Tests, Results of 1964, Volume 20.

The American Phytopathological Society. 1975. Fungicide - Nematocide Tests, Results of 1974, Volume 30.

Stevens, George. Professor. 1977. Farm Data Manual Planning Data for Farming in Maryland. Input-Output Costs and Returns. University of Maryland. Cooperative Extension Service. College Park. August.

Tarzy, Robert. 1978. USDA, Price Support and Loan Division. Personal Communication. 20 April.

Todd, Furney A., Professor of Plant Pathology. 1978. North Carolina State University. Raleigh. Personal Communication. 1 February.

Todd, Furney A., Professor of Plant Pathology. 1978a. North Carolina State University. Raleigh. Personal Communication. 21 August.

USDA, ASCS, TPD. 1977. Tobacco Allotted by Counties and by Kinds. Washington, D.C.

USDA, ERS. 1974. Tobacco Situation, TS-149. Washington, D.C. September.

USDA, ESCS. 1978. Tobacco Situation, TS-163. Washington, D.C. March.

USDA, ESCS. 1978a. Tobacco Situation, TS-164. Washington, D.C. June.

USDA, ESCS, CRP. 1978b. 1977 Annual Crop Summary, CrPR 2-1(78). Washington, D.C. January.

Virginia Polytechnic Institute and State University, Extension Division. 1977. Chemical Control of Insects, Disease, and Needs for Tobacco. Pest Management Series 6. January.

Wells, Jim. Assoc. Professor. 1978. Ohio Agricultural Research and Development Center. Wooster. Personal Communication. 31 August.

Whitty, E. Ben, Professor, Extension Agronomist. 1978. University of Florida. Gainesville. Personal Communication. 30 August.

SUMMARY OF PRELIMINARY BENEFIT ANALYSIS
EBDC USE ON WILDRICE

A. USE: Wildrice

B. MAJOR PESTS CONTROLLED: Leaf spot diseases caused by the fungus *Helmintrosporium sativum*.

C. ALTERNATIVES:

Major registered chemicals: None.

Non-chemical controls: None.

D. EXTENT OF USE: 96,000 pounds of active ingredient applied 15,000 acres in Minnesota annually. A maximum of 23,000 acres are capable of pro wildrice, however, only a portion of this is cultivated in wildrice any given year. is estimated that approximately 90 percent the acreage planted is treated with EBDC foliar protectants.

E. ECON MIC IMPACTS: The economic impacts associated with cance lation are anticipated to be major. With cancellation of EBDC use on wildrice yield are expected to decline approximately 15 pe The cost of EBDC protection is approximate $21.50 annually, however, the value of los production is estimated at $214.00 per acr The magnitude of revenue losses associated cancellation and the relatively low cost o treatment indicated that either the price wildrice would have to rise significantly t cover the increased costs of production, or crop will no longer be commercially produce

F. PRINCIPAL ANALYST AND DATE: Linda V. Zygadlo, Economist
Economic Analysis Branch
Benefits and Field Studies Division
Office of Pesticide Programs
November, 1978

Current Use Analysis

Wildrice is a minor crop grown only in Minnesota.[1] Approximately 23,000 acres of land are diked and capable of producing paddy rice (USDA/State/EPA, 1978; Oelke, 1978). Only a proportion of this acreage is cultivated in wildrice because of rotations with other crops. Approximately 96,000 pounds active ingredient of EBDC fungicides are applied as foliar protectants to 15,000 acres of wildrice annually (Pelletier, 1978). These fungicides are used to protect wildrice from several leaf spot diseases. The most important leaf spot disease caused by the fungus Helminthosporium sativum can completely destroy the crop in some years (USDA/State/EPA, 1978). There are no registered alternatives to EBDC fungicides for use on wildrice to control leaf spot diseases (Pelletier, 1978a).

Performance Evaluation

EBDC fungicides are applied to wildrice at the rate of 1.6 pounds active ingredient per acre; generally four applications, the maximum registered, are made annually (Pelletier, 1978a; USDA/State/EPA, 1978).

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[1]Published data indicating average yields, acres harvested, value of production, etc. are unavailable for wildrice. Neither USDA nor the state of Minnesota collects data on this crop.

The Plant Studies Branch (Pelletier, 1978b.) reviewed test data for wildrice yields with and without the use of EBDC fungicides. Field tests were conducted at a total of eight locations over a period from 1974 to 1977. Among those tests at which mancozeb was applied four times at the label rate of 1.6 pounds active ingredient per acre, the average yield of wildrice for mancozeb-treated plots was 722 pounds per acre, the average yield for the non-treated plots was 615 pounds per acre; these yields represent an average yield loss of 107 pounds per acre, due to the disease. The yield ranges were 1,593 to 398 and 456 to 336 pounds per acre for the treated and non-treated plots respectively (Pelletier, 1978b).

ECONOMIC IMPACTS

Because of the magnitude of yield losses anticipated with the cancellation of EBDC, economic impacts are expected to be major. The cost of EBDC foliar protection on wildrice is approximately $21.57 per acre annually (four applicationsof 1.6 pounds of EBDC active ingredient at $2.12 per pound plus a $2.00 application charge per treatment). The farm level price of wildrice is approximately $2.00 per pound (Oelke, 1978; Bissonnette, 1978). The value of estimated yield losses without EBDC protection is $214.00 per acre, approximately 15 percent of the gross revenue obtained with the use of EBDC on wildrice. The potential revenue losses associated with cancellation and the relatively low cost of treatment indicate that cancellation would result in major impacts. Either the price of wildrice would have to rise significantly to cover the increased costs of production, or the crop will no longer be commercially produced.

SOURCES CONSULTED

Bissonnette, Howard. 1978. Extension Plant Pathologist, Agricultural Extension Service, University of Minnesota, Personal Communication with N. Pelletier 14, November.

Oelke, Ervin. 1978. Department of Agronomy and Plant Genetics, University of Minnesota, Personal Communication with L. Zygadlo, 15 November.

Pelletier, E.N., 1978a. EBDC Use Profile for Economic Analysis - EBDC Fungicides. Washington D.C. 14 August.

———— 1978b. Yield Data in Support of Benefits Analysis-- Mancozeb Use on Wildrice. Washington D.C. 30 November. USDA/State/EPA. 1978. Assessment of Ethylenebisdithio-Carbamate (EBDC)

Fungicides Uses in Agriculture. Washington D.C. April.

SUMMARY OF PRELIMINARY BENEFIT ANALYSIS - USE OF EBDC

AS A FOLIAR PROTECTANT ON SMALL GRAINS

A. USE: EBDC use as a foliar protectant applied to small grains

B. MAJOR DISEASES CONTROLLED: Leaf spotting plant diseases

C. ALTERNATIVES:

Major registered chemicals: None

Non-chemical controls: None

D. EXTENT OF USE:

Crop	Acres treated	% of total acres harvested	AI applied pounds
wheat	1,000,000	1.5	4,000,000
barley	400,000	4.6	1,600,000

E. ECONOMIC IMPACTS:

User: Although production costs on the affected acres of wheat and barley will decline if EBDC is cancelled, uncontrolled plant diseases will result in decreased yields and therefore decreased gross revenues. The combined impacts will result in net revenue losses of $5.77 and $7.52 per acre to EBDC users producing wheat and barley respectively. Aggregate users impacts of $5,770,000 will be experienced by wheat producers; barley producers will experien impacts of $3,008,000. Total cancellation costs to users will approximate $8,778,000 annuall until alternative plant disease control methods are developed.

Market, Consumer: If the 1.4 million EBDC treated small grain acreage remains in produ tion, total U.S. wheat a barley production would be reduced .33 and 1.01 percent respectively. Assuming all EBDC-trea acreage is shifted to alternative crops, total U.S. wheat and barley production would be redu 1.5 and 4.6 percent respectively. Even the "worst-case" supply reductions would be anticipat to result in minor price adjustment at the market and consumer level.

F. METHOD OF APPLICATION: Aerial

G. LIMITATIONS OF ANALYSIS: The analysis was developed assuming yield losses of 22% on currently treated acreage, if EBDC was unavailable for disease control of wheat and barley. Alternative yield losses estimated would alter the magnitude of benefits associated with EBDC use on small grains.

H. PRINCIPAL ANALYST AND DATE:

Linda V. Zygadlo
Economist
Economic Analysis Branch
Benefits and Field Studies Division
November 1978

SMALL GRAINS

Current Use Analysis

Approximately 5.6 million pounds active ingredient of EBDC fungicides are applied as foliage protectants to 1.4 million acres of barley (400,000 acres) and wheat (1,000,000 acres) annually (Pelletier, 1978). These fungicides are used to protect cereal crops from diseases such as Leaf Rust, Septoria Leaf Blotch, Net Blotch, Spot Blotch, and Brown Spot. These plant diseases attack and destroy the cereal plant leaves causing major crop losses (USDA/State/EPA, 1978). There are no registered alternatives to EBDC fungicide for use on cereal crops (Pelletier, 1978).

Performance Evaluation

EBDC fungicides are applied to small grains at the rate of 1.6 pounds active ingredient per acre at an average of 2.5 treatments annually, the number of EBDC applications being dependent on disease incidence. A maximum of 3 applications may be applied per season (Pelletier, 1978). The Assessment of Ethylenebisdithiocarbamate (EBDC) Fungicide Use in Agriculture (USDA/State/EPA, April 1978) indicates that "on farm tests" in North Dakota showed the use of EBDC foliage protectants on spring wheat increased yields an average of 28 percent. There are no alternative fungicides which can be used for the protection of cereal grains from the various leaf spotting plant diseases; resistant crop varieties have not been developed (USDA/State/EPA, 1978).

Economic Impacts

The economic impacts of an EBDC cancellation will result from a reduction in small grain production costs (since alternative disease control measures and unavailable) and yield losses experienced due to uncontrolled plant diseases. The economic impacts associated with the cancellation of EBDC are presented in Table IV-10. With the cancellation of EBDC as a small grain foliage protectant, annual production costs would be reduced an average of $13.48 per acre (2.5 treatments of EBDC applied at 1.6 lbs./ai per acre, chemical costs average $2.12 per pound ai and aerial application charges of $2.00 per acre) on 1.0 and 0.4 million acres of wheat and barley respectively (Pelletier, 1978; EPA price lists).

If the North Dakota test results indicating an average yield increase of 28 percent on spring wheat (UASDA/State/EPA, 1978) is assumed representative of yield changes resulting from foliage protection of other small grain crops, production would decrease 22 percent on EBDC treated acreage if foliar treatments are cancelled.

A 22 percent yield loss would result in production losses valued at approximately $19.25 and $21.00 per acre in wheat and barley respectively.[1/]

[1/] Based on 1975-1977 average yields of 30.5 and 44.2 bushels and average prices of $2.87 and $2.16 per bushel in wheat and barley respectively.

TABLE IV-10 ECONOMIC IMPACTS GIVEN CANCELLATION OF EBDC FOLIAR APPLICATIONS ON SMALL GRAINS

Crop treated	U.S. area harvested 1/	EBDC area treated 2/		Annual cost of EBDC treatment 3/	Value of lost production 4/	Net revenue changes	Aggregate impacts
	(acres)	(acres)	(percent)	- - - -	$/acre	- - - -	$
wheat	68,790,000	1,000,000	1.5	$13.48	$19.25	$5.77	$5,770,000
barley	8,770,000	400,000	4.6	13.48	21.00	7.52	3,008,000

1/ 1975-1977 U.S. average

2/ Pelletier, 1978

3/ 1.6 lbs. ai per acre at $2.12/lb. ai; $2.00 aerial application charge; 2.5 treatments annually.

4/ Assumes 22 percent yield loss; based on 1975-1977 average yields of 3.05 and 44.2 bushels and prices of $2.87 and $2.16 per bushel in wheat and barley respectively.

The combination of reduced production costs and reduced small grain production would result in net revenue losses of $5.00 and $7.52 per acre to wheat and barley growers respectively. Small grain producers currently applying EBDC would experience aggregate net revenue losses of $8,778,000 annually.

If the 1.4 million acres of small grains treated with EBDC remain in production total U.S. wheat and barley production would decline 0.33 percent and 1.01 percent respectively. If the net revenue reductions indicated above were severe enough to eliminate small grain production on EBDC treated acreage, U.S. wheat and barley production would decline approximately 1.5 and 4.6 percent respectively. Even the "worst-case" supply reductions of 1.5 and 4.6 percent would, at the most, result in minor price changes at the consumer level.

Limitations of Analysis

The analysis of the benefits of EBDC use as a foliage protectant on small grains was developed assuming that the use of EBDC results in yield increases of 28 percent. Any change in this assumption would alter the magnitude of benefits associated with EBDC use on cereal crops.

SECTION V.

POTATOES

POTATOES

Introduction

Potatoes are grown in every State within the continental U.S. including Alaska. Over 1.3 million acres are harvested annually with production at 338 million cwt. (Table V-1). The top 10 producing States are spread across the northern U.S. (Table V-2). Idaho is the leading potato producing State accounting from 25.5 percent of the acreage and 24.3 percent of the production.

Potatoes are treated with fungicides to protect them against two major foliar diseases; late blight (*Phytophthora infestans*) and early blight (*Alternaria solani*). Late blight is the major problem in areas of high humidity as typified by the "eastern" States. These "eastern" States grow 453,200 acres of potatoes or 33.8 percent of the U.S. total (Table V-1). Early blight, which is also prevalent in the areas where late blight is found, is the major fungal problem in the arid regions typified by "western" States. These "western" States grow approximately 890,000 acres of potatoes or 66.2 percent of the U.S. total (Table V-1).

The names "early" and "late" do not specifically relate to order of occurrence. In areas where both diseases are prevalent, treatment is simultaneous. In most portions of the country a seed piece treatment against *Fusaria*, *Rhizoctonia* and scab also takes place.

Assumptions and Procedures

Foliar treatment:

The following assumptions were used in estimating the economic impact of the cancellation of the EBDC fungicides for early and late blight treatment.

1. The major potato producing States in the East and West regions are listed in Table V-1. Climatic and disease conditions differ between the two regions but are similar with in each region. The average acreage harvested for 1974-1976 was used as the base acreage. (This acreage varied from planted acreage by less than 3 percent) (Table V-3).

2. The most likely alternatives to mancozeb (an EBDC) were specified by the Assessment Team and are captafol and chlorothalonil. Both will control late and early blight as well as or slightly better than EBDC. Therefore, no yield change was included in the analysis.

3. It was assumed that both of these alternatives would be available in sufficient quantities and at the present price level. This assumption was strongly questioned by some members of the Assessment Team. If this assumption is incorrect the calculated cost differences underestimate the economic benefit of the EBDC's.

4. The costs of application and number of treatments were assumed by the Assessment Team to be identical for both EBDC and the alternatives at 6 treatments for late blight and 2 to 4 treatments for early blight.

5. Chemical costs per acre are \$3.20 for mancozeb, \$4.00 for captafol and \$5.32 for chlorothalonil.

Seed piece treatment:

The following assumptions were used in estimating the economic impact of the cancellation of the EBDC fungicides for potato seed piece treatment.

1. That 92 percent of the potato acreage is planted with seed pieces treated with fungicides and 65 percent of this is EBDC fungicides.
2. That mancozeb is the EBDC fungicide used.
3. That captan is the fungicide that will replace mancozeb and in most cases is at least as effective. No stand reduction or yield impact is included in the analysis.
4. Application techniques and costs are similar for both fungicides.
5. Chemical costs for mancozeb are \$4.15 per acre and \$4.68 per acre for captan based on a seeding rate of 18 cwt per acre (1, p. 109, 2, p. 286-287).

Current Use

Foliar treatment:

Although several EBDC fungicides (mancozeb, maneb, and zineb) are registered for foliar treatment of potatoes, mancozeb is the one most commonly used for late and early blight control (1, p. 109). Maneb costs about the same as mancozeb but its use has been declining. Zineb is not considered as effective as mancozeb or maneb.

Mancozeb is formulated as an 80 percent wettable powder. It is applied at the rate of 1.6 pounds of active ingredient (a.i.) per

treatment per acre for either late or early blight control. To control late blight growers must apply a protective fungicide before the epidemic begins and repeat applications on a 7-10 day interval depending on weather conditions. An average of 6 treatments are required per season (Table V-4). It was estimated that 265,100 acres of potatoes are treated for late blight with about 2.5 million pounds (a.i.) of mancozeb.

Generally, 2 to 4 fungicide applications are sufficient to control early blight. An estimated 416,100 acres of potatoes are treated with mancozeb annually requiring 1.3 to 2.6 million pounds of active ingredient. Mancozeb costs about $2.00 per pound of active ingredient.

Seed piece treatment

Seed piece treatment with a fungicide is necessary on virtually all of the U.S. potato acreage. Of the total U.S. acreage of 1.34 million acres approximately 92 percent is planted with treated seed pieces. It was assumed by the Assessment Team that 65 percent of the acreage was planted with EBDC treated seed pieces. Mancozeb is the material of choice and is applied at 0.08 pounds active ingredient per 100 pounds of potato seed pieces. At an estimated seeding rate of 18 cwt. per acre, about 1.2 million pounds (a.i.) of mancozeb are used annually for seed piece treatment.

Alternatives

Foliar treatment

The most likely alternatives to EBDC for foliar spraying are captafol and chlorothalonil. Both will control late and early blight

as well as or slightly better than EBDC. Captafol is applied at a rate of 1.5 pounds (a.i.) per acre (4 lb. per gallon flowable). Chlorothalonil is applied at a rate of 1.125 pounds (a.i.) per acre (6 lb. per gallon flowable). Captafol costs $2.69 per pound (a.i.) and chlorothalonil $4.73 per pound (a.i.) (1).

Seed Piece Treatment

Fungicidal seed piece treatment is effective against *Fusaria* and *Rhizoctonia*. Against *Fursaria*, mancozeb appears to be slightly more effective than the alternative. Against *Rhizoctonia*, captan is equal to or better than mancozeb. Against scab the relative effectiveness seems to vary dependent upon the location of the acreage or weather conditions with variation being slight. Captan is applied at 0.075 pounds (a.i.) per 100 pounds of potato seed pieces. It costs approximately $3.47 per pound (a.i.), compared to $2.88 per pound (a.i.) for mancozeb (1, p. 109)

User Impact

Foliar treatment

Control costs with mancozeb for late blight are estimated at $5.1 million (Table V-4). If mancozeb use is cancelled and growers replace it with captafol, disease control costs are estimated at $6.4 million or $1.3 million more than with mancozeb. If all growers switched to chlorothalonil, a more expensive alternative, late blight control costs are estimated at $8.5 million an increase of

$3.4 million over mancozeb treatment. On a seasonal basis, captafol cost $4.80 and chlorothalonil $12.72 more per acre than a mancozeb treatment.

For early blight, control costs with mancozeb are estimated at $2.7 to $5.3 million depending on whether 2 to 4 applications are needed per season (Table V-4). Disease control costs are estimated to range from $3.3 to $6.7 million if all growers switched to captafol and from $4.4 to $8.9 million if all growers switched to chlorothalonil. If mancozeb is cancelled, control costs for early blight are estimated to increase between $0.6 million and $3.6 million depending on fungicide used and number of applications needed per season. Per acre (based on 3 applications per season) disease control costs would increase $2.40 with captafol and $6.36 with chlorothalonil compared to current costs with mancozeb. However, it has not been determined if the alternatives will exist in quantities large enough to replace EBDC.

Seed piece treatment

The difference in treatment costs between mancozeb ($4.15 per acre) and captan ($4.68 per acre) is 53 cents per acre. This difference is not large enough to warrant the calculation of a national economic impact. A multitude of factors such as farmer preference, dealer salesmanship and availability determine which fungicide material a grower uses for seed piece treatment.

Consumer Impact

Because it was assumed that the alternative fungicides were equally efficacious as mancozeb, no change in potato production was estimated as a result of an EBDC cancellation.

The increase in disease control costs as a result of shifting to alternative fungicides if the EBDC fungicides are cancelled would probably be borne by growers. The increased cost of $4.80 to $12.72 per acre for late blight control may force some marginal growers out of business but the impact on potato production would be slight.

The farm value of the 1975 potato crop was estimated at $1.3 billion. The extreme cost increase, estimated at $7.0 million if all growers switched to chlorothalonil is less than 1 percent of the farm value of the potato crop. Normal yearly variation in potato production and the volume in storage regularly cause much wider fluctuations in potato prices. The impact of the cancellation of the EBDC fungicides would have an indeterminable impact on potato prices at the consumer level if the alternatives exist in quantities large enough to replace EBDC.

Sources Consulted

1. USDA/State/EPA Assessment Team. 1978. Assessment of EBDC Fungicide Uses in Agriculture, Washington, D.C., September.

2. USDA. 1977. Agricultural Statistics - 1977, Washington, D.C.

3. USDA, SRS. 1977. Potatoes and Sweetpotatoes - 1975-76 Production, Disposition, Value, Stocks and Utilization, Pot 6 (77), Washington, D.C., August

4. Cetas, R.C. 1976. Estimated Use Cost of Foliar and Seedpiece Treatment - Fungicides on Potatoes East of Mississippi River in 1976 (Mimeo copy).

5. Corsini, D. 1978. Fungicide Usage Related to Potato Disease Problems in the Western U.S., USDA, ARS (Mimeo copy).

6. Latin, R.X. et al. No date. Crop Loss Prediction Tables for Potato Late Blight Epidemics, Pennsylvania State University, University Park, Pa. (Mimeo copy)

7. Ballard, C. 1977. Economic Consequences for Restriction of EBDC on Potatoes, EPA, Washington, D.C.

Table V-1. Potatoes: Acres harvested and volume of production, U.S., 1974-76 a/

Region and Subregion	Area: 1,000 acres	Area: Percent of U.S. total	Production: 1,000 cwt.	Production: Percent of U.S. total
East				
North-East b/	224.0	16.7	54,863	16.2
Great Lakes c/	111.9	8.3	28,580	8.4
Mid-Atlantic d/	56.8	4.2	7,638	2.3
South e/	55.3	4.1	9,071	2.7
Other f/	5.2	.4	447	.1
Total	453.2	33.8	100,599	29.7
West				
North-West g/	527.7	39.3	159,078	47.0
Mid-West h/	231.4	17.2	39,090	11.6
South-West i/	76.3	5.7	25,875	7.6
Rocky Mountain j/	53.7	4.0	13,814	4.1
Total	889.1	66.2	237,857	70.3
Grand Total	1,342.3		338,456	

a/ Average for years 1974, 1975, 1976. Data from USDA, Agricultural Statistics 1977, USGPO, Wash. D.C., 1977. Table 249, p. 180

b/ Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

c/ Illinois, Indiana, Michigan, Wisconsin, Ohio

d/ Maryland, North Carolina, Virginia, West Virginia, Delaware

e/ Alabama, Florida, Louisiana, Mississippi

f/ Tennessee

g/ Idaho, Washington, Oregon, Nevada, Montana

h/ North Dakota, Minnesota, Texas, Nebraska, South Dakota, Iowa

i/ California, Arizona, New Mexico

j/ Colorado, Wyoming, Utah

Table V-2. Potatoes: Acres harvested and production by major States, 1974-1976 a/

State	Acres harvested: Average 1974-76	Acres harvested: Percent of 3 year total	Production: Average 1974-76	Production: Percent of 3 year total	
	1,000		--- million cwt ---		
California	65.5	4.9	23.2	6.9	
Oregon	57.0	4.2	23.6	7.0	
Washington	109.0	8.1	48.4	14.2	
	231.5	17.2	95.2	28.1	
Idaho	342.3	25.5	82.2	24.3	52.4
North Dakota	122.0	9.1	19.2	5.7	
Minnesota	77.9	5.8	14.5	4.3	
	199.9	14.9	33.7	10.0	62.4
Michigan	40.1	3.0	9.2	2.7	
Wisconsin	50.8	3.8	14.8	4.4	
	90.9	6.8	24.0	7.1	69.5
Maine	124.7	9.3	30.2	8.9	
New York	50.0	3.7	13.1	3.9	
	174.7	13.0	43.3	12.8	82.2
Total U.S. b/	1,342.3		338.5		

a/ State data for 1974 from Agricultural Statistics - 1977, USDA, Washington, D.C. Data for 1975 and 1976 from Potatoes and Sweetpotatoes-1975-76, USDA, SRS, Pot 6 (77), Washington, D.C., August.

b/ Table V-1.

Table V-3. Potatoes: Area planted and acres harvested a comparison for years 1974-75-76, data for total U.S. a/

Year	Area			Difference as a percent of planted
	Planted	Harvested	Difference	
	1,000 acres			Percent
1974	1,421.0	1,390.8	30.2	2.12
1975	1,301.7	1,261.8	39.9	3.06
1976	1,406.3	1,374.1	32.2	2.29

a/ Data from USDA, Agricultural Statistics 1977, Wash., D.C. 1977, Table 248, p. 179.

Table V-4. Per acre and total disease control costs for late and early blight with EBDC and the alternatives to replace it if the EBDC fungicides are cancelled for use on potatoes

Disease and treatment	Total susceptible acre a/	Percent of acreage infected b/	Percent acres treated with EBDC b/	Acreage treated with EBDC	Chemical cost per treatment per acre b/	Treatment per acre per year b/	Total costs per acre	Total cost on acres treated	Increased cost without EBDC
	1,000			1,000	dollars	number	dollars	--- million dollars ---	
Late blight									
Mancozeb	453.2	90	65	265.1	3.20	6	19.20	5.1	
Alternatives									
Captafol					4.00	6	24.00	6.4	1.3
Chlorothalonil					5.32	6	31.92	8.5	3.4
Early blight									
Mancozeb	889.1	78	60	416.1	3.20	2-4	6.40-12.80	2.7 - 5.3	
Alternatives									
Captafol					4.00	2-4	8.00-16.00	3.3 - 6.7	.6 -1.4
Chlorothalonil					5.32	2-4	10.64-21.28	4.4 - 8.9	1.7 -3.6

a/ Table V-1
b/ Based on information from the Assessment of EBDC Fungicide Uses in Agricultura, USDA/State/EPA Assessment Team, Washington, D.C., September 1978

SECTION VI

MUSHROOMS

MUSHROOMS

Introduction

The domestic production of mushrooms has grown rapidly and in 1977 was valued at $307 million (Table VI-1). The majority of this crop (56 percent) enters the fresh market. Total production for the 1977-78 crop year was almost 400 million pounds (Table VI-2). Of this amount, about 60 percent were grown in Pennsylvania and it is estimated that another 20 percent were grown in California. (1) Over the past 10 years, the average annual increase in production has been 8.3 percent (Table VI-2). Historically, imports represent about 20 - 30 percent of U.S. consumption. The price of mushrooms has more than doubled over the past decade and has kept pace with the rise in the consumer price index (Table VI-4).

Disease Problem

The ideal conditions for growing mushrooms are also the ideal conditions for growth of the fungal pathogens of mushrooms. Modern intensive tray production under controlled environmental conditions has increased the number of possible crops per year from 1 or 3, to, in some cases, 6 or 7 per year. In 1948, mushroom beds produced an average of 1.5 pounds of mushrooms per filling. (6) The present production average is 3.0 pounds per filling. Modern production has also accentuated the problem of dissemination, innoculation, incubation, and infection by pathogens.

The major diseases of the commercial mushroom crops are "dry bubble" (*Verticillium malthousei*), "wet bubble" (*Mycogone pernicosa*), and mildew (*Dactylium dendroides*). *Verticillium* is considered by mycologists to be the most prevalent disease problem in this country. *Tricoderma* and LaFrance disease are highly important world wide, but are presently of lesser importance in the U.S.

The continued successful cultivation of mushrooms is an art which requires a large amount of expertise. Of extreme importance is the preparation of the growing medium. This operation is usually supervised directly by the most experienced employee or owner. The condition of the medium determines the strength of the culture and may be strongly correlated with disease resistance. Newer firms, and in some cases, those that have changed management, are operating without the benefit of the level of expertise formerly existing in the industry.

Current EBDC Use

In the western portion of the U.S. (basically California), 90 percent of the crop was treated. In the eastern portion of the U.S., approximately 60 percent of the crop was treated. The difference in these percentages is due to a higher proportion of the crop being grown under intensive tray production in the California. Zineb is normally sprayed 10 times per filling as a powder over the beds. The label rate is .0000187 pounds (a.i.) per square foot of bed per treatment.

Alternatives

Chemical:

If zineb treatment were cancelled, the use of benomyl would be substituted. No other suitable chemical fungicide alternative exists. Benomyl is not considered by many researchers to be a viable alternative because when benomyl is not used in combination with zineb, the resistance of *Verticillium* to benomyl may render benomyl ineffective.

Zineb appears to attack some strains of *Verticillium* more effectively than benomyl and the two sprayed independently over a number of treatments seem to have a complementary effect. It appears *Verticillium* strains that are more resistant to benomyl are more highly susceptable to control by zineb and vice versa. The continued effectiveness of benomyl is considered to be dependent upon the continued intermittant use of zineb when benomyl resistance is encountered. In some cases after only 9 months of continued benomyl use, resistance is found.

Benomyl is sprayed at a label rate of .0000625 pounds (a.i.) per square foot with an average of 3 applications per filling. Under present use, it is estimated by the Assessment Team that from 55 to 75 percent of the crop in the western U.S. is sprayed with both benomyl and zineb. The same is true of 30 to 35 percent of the crop in the eatern U.S. The combination seems to be more effective (7, 8).

Cultural:

A portion of the pathology problems that exist in mushroom culture can be traced to the strains of mushrooms grown. Snow-white mushrooms command a premium price and are the preferred choice of growers. This strain is also the most suceptable to *Verticillium* attack. The off-white varieties are less suceptable to attack but also are considered less desirable because of color. No taste difference has been noted. None of the presently known strains of commercial mushrooms are exempt from attack by *Verticillium*. They vary only in the level of susceptability.

The search for resistant strains would be necessary if continued zineb and benomyl use were not allowed. This would also be true if zineb use was cancelled and benomyl use continued because of resistance problems with benomyl. Such research is not presently being conducted and the time frame required to develop resistant strains is not known.

Another portion of the problem can be traced to the intensive production methods now taking place. These methods enhance the probability of disease infestation occurring. Without zineb production methods could be changed, but the cost of production would be expected to increase significantly.

Assumptions and Procedures

Short-run:

1. An effective substitute for zineb does exist.
2. The substitute is applid in a similar manner, but is more costly.

3. All benefits are due to the cost difference between zineb and its alternative.

Long-run:

1. Resistance will build up against the short-run alternative (benomyl) to zineb. In the long-run, no viable alternative to zineb exists.

2. If zineb is not available, mushroom damages of between 9 and 13.5 percent may be expected.

User Impact

The effect upon growers is expected to be highly variable and highly regional. Part of this variation is due to both the manner and level of production. As was noted earlier, the large intensive tray operations are presently centered in the western States, primarily California, and would probably be the most affected. This is due to the ideal growth conditions existant under this method for the pathogens and delicacy of the conditions under which production is continued throughout the year. As noted earlier, the small producers through artful preparation of the growing medium, may be, in some cases, less affected. The amount of capital available to small growers to maintain them through sustained periods of crop loss is probably also more limited.

In the short-run, not spraying with zineb would mean substitution of benomyl until resistance to benomyl reduced its effectiveness to a non-economic level.

The estimated present control costs are $109,120 to $115,280 for zineb treatment. Control costs with benomyl are expoected to be $580,800 to $646,800.

An increase in control costs in the short-run of $465,500 to $537,700 is expected with no change in the quanlity or quantity of mushrooms grown.

In the long-run, estimated damage from 9 to 13.5 percent of the crop without the availability of zineb (1, p. 137-138). Of the 263,000 million pounds treated (Table VI-6), this would amount to a damge loss on between 23.7 and 35.5 million pounds. The damage losses are estimated to range from $2.8 to $4.3 million. The cost reduction caused by no longer spraying with benomyl is expected to range from $580,800 to $646,800. The net loss expected is $2.15 to $3.72 million.

Consumer Impact

The impact upon consumers is difficult to determine. In the short-run, grower cost will increase. It is expected that this cost increase might be partially absorbed by the marketing margin with the remaining increase passed on to the consumers.

In the long-run, with no chemical alternative, it is expected that a number of growers wil find it impossible to remain in production. This is especially true of the new large more intensive production units.

Sources Consulted

1. USDA/State/EPA Assessment Team,"Assessment of EBDC Fungicide Uses in Agriculture", Washington, D. C., September 1978.

2. Harvey, Cathy L. and Paul J. Wuest, The Nature of Disease Resistance Among Three Strains of Cultivated Mushroom, Agaricus brunnescens. Department of Plant Pathology, Pennsylvania State University, University Park, Pennsylvania. (One page reproduction)

3. Kligman, Albert M., Handbook of Mushroom Culture, published by J. B. Swayne, Kennett Square, Pennsylvania, 1950.

4. Retter, G. Raymond, Manual of Mushroom Culture. 1948. Mushroom Supply Company, Toughkenamon, Pennsylvania, 4th edition, 2nd paragraph, page 271.

5. USDA, Agricultural Statistics 1977, Washington, D. C.

6. USDA, ESCS, Mushrooms, Vg 2-1-2(8-78), August 11, 1978.

7. Wuest, P. J. and D. H. Lambert, Increased Sensitivity to Zineb for Verticillium malthousei Strains Tolerant to Benomyl. Reprint from PHYTOPATHOLOGY, May 1975, Volumn 65, number 5.

8. Wuest, P. J., H. Cole, and T. G. Patton, Influence of Benomyl on Mushroom Production, Pennsylvania State University, Plant Pathology Journal Series 3961, Contribution 620, Can. J. Plant Sci. 52:811-815 (September 1972.

Table VI-1. Value of U.S. mushroom production and imports, 1967-77

Year	Domestic production a/ Total	Fresh	Processed	Imports b/ Total	Imports as a portion of total imports plus domestic production
	---- million dollars ----				percent
1967	61.7	21.4	40.3	12.3	16.6
1968	67.9	25.8	42.0	14.7	17.8
1969	72.7	28.0	44.7	14.4	16.5
1970	89.6	31.7	57.9	17.5	16.3
1971	106.9	38.4	68.5	23.7	18.1
1972	110.0	42.6	67.4	38.8	26.1
1973	123.4	58.4	64.9	35.4	22.3
1974	147.2	76.6	70.7	33.6	18.6
1975	191.1	102.2	88.9	43.6	18.6
1976	255.7	124.6	131.1	65.2	20.3
1977	307.6	172.2	135.4	n.a.	n.a.

n.a. - not available
a/ USDA, Agricultural Statistics 1977, Table 379, p. 265.
b/ USDA, Agricultural Statistics 1977, Table 380, p. 265.

Table VI-2. Mushrooms: Total U.S. production and percent increase in volume over previous season, 1966-78 a/

Year	Total production	Amount above previous year: Volume	Amount above previous year: Percent
	1,000 lbs.	1,000 lbs.	
1967-68	180,591	--	--
1968-69	188,807	8,216	4.5
1969-70	193,879	5,072	2.7
1970-71	206,810	12,931	6.7
1971-72	231,373	24,563	11.9
1972-73	254,002	22,629	9.8
1973-74	279,493	25,491	10.0
1974-75	299,081	19,588	7.0
1975-76	309,816	10,735	3.6
1976-77	347,129	37,313	12.0
1977-78	398,703	51,574	14.9

a/ USDA, ESCS, Mushrooms, Vg 2-1-2(8-78), August 1978.

Table VI-3. Mushrooms grown under glass or other protection: farms, square feet, and value of sales, 1974 a/

State	Farms		Square feet of beds		Value of sales	
	no.	percent	million sq. ft.	percent	million dollars	percent
Pennsylvania	370	71.4	31.61	64.2	69.07	51.1
California	36	6.9	5.03	10.2	25.41	18.8
Michigan	14	2.7	3.86	7.8	11.90	8.8
Illinois	15	2.9	1.06	2.2	5.12	3.8
Ohio	7	1.4	1.12	2.3	3.47	2.6
New York	13	2.5	1.40	2.8	2.83	2.1
Delaware	14	2.7	1.12	2.3	1.93	1.4
Florida	4		.32		.83	
Maryland	9		.45		.67	
Minnesota	4		.14		.28	
New Jersey	8		.35		.20	
Utah	3		.09		.12	
Sub-total	497		46.55		121.83	
Total U.S. b/	518		49.25		135.08	

a/ Data from 1974 Census of Agriculture-State Miscellaneous Data III-39, Table 13.
b/ Indiana, 4 growers, State included in total U.S. row only due to disclosure problem.

Table VI-4. Mushroom price and supply data, 1967-77

Year	Wholesale price of mushrooms a/		Consumer price index b/	Normalized mushroom price index c/
	cents/ pound	index d/	index d/	index d/
1967	34.1	100	100	1.00
1968	35.9	105.3	104.2	1.011
1969	37.5	110.0	109.8	1.002
1970	43.3	127.0	116.3	1,092
1971	46.2	135.5	121.3	1.117
1972	43.3	127.0	125.3	1.01
1973	44.1	129.3	133.1	.97
1974	49.2	144.3	147.7	.98
1975	61.7	180.9	161.2	1.12
1976	73.7	216.1	170.5	1.27
1977	77.1	226.1	--	—

a/ USDA, Agricultural Statistics 1977, p. 265.
b/ Consumer Price Index-all items, USDA Agricultural Statistics 1977, Table 764, p. 569.
c/ Wholesale price index divided by consumer price index.
d/ 1967 = 100.

Table VI-5. Mushrooms: Disease pest control costs with zineb (an EBDC) and benomyl

Item	Units	Zineb	Benomyl
		Per sq. ft. of bed or tray	
Application rate a/	lbs. a.i.	.0000187	.0000625
Chemical cost per application b/	cents	.00337 to .004114	.1 to .125
Application costs c/	dol.	.009	.12
Total cost per application	dol.	.01237 to .013114	.22 to .245
Applications per filling c/	no.	10	3
Control cost per filling	cents	.124 to .131	.66 to .735
Cost difference between zineb and benomyl	cents	—	+.611 to +.529
Production per filling c/	lbs.	3.0	3.0
Mushroom price per pound c/	cents	77.1	77.1
Mushroom value per filling	dol.	2.313	2.313
Control cost relative to product value	percent	.054 to .057	.285 to .318

a/ Based on manufacturer's label.
b/ Based on a price of $1.80 to $2.20 per pound (a.i.) for zineb and $16 to $20 per pound (a.i.) for benomyl. These prices were developed by the Assessment Team based on their knowledge of the pesticide market and manufacturer's price lists.
c/ Based on information from "Assessment of EBDC Fungicide Uses in Agriculture", USDA/State/EPA Assessment Team, Washington, D. C., September 1978.
d/ USDA, ESCS, Mushrooms, Vg 2-1-2(8-78), Washington, D. C., August 1978.

Table VI-6. Regional breakdown of mushroom crop and proportion treated with zineb (an EBDC fungicide), 1977-78 crop year

Region	Millions of pounds grown a/	Percent of crop treated b/	Crop treated: Million pounds	Crop treated: Million sq. ft. c/
East	319	60	191	64
West	80	90	72	24
U.S. Total	399	—	263	88

a/ The distribution between East (80 percent) and West (20 percent) was based on data from the 1974 Census of Agriculture and applied to 1977-78 production data. USDA, ESCS, Mushrooms, Vg 2-1-2(8-78), Washington, D. C., August 1978.

b/ Estimated by the Assessment Team.

c/ Based on 3.0 pounds of mushrooms per square foot per filling (Table VI-5).

Table VI-7.- Mushrooms: Grade production expectations and price differentials compared utility spotted a/

Grade of mushroom	Percent of crop	Price per pound b/	Wholesale price difference c/	Weighted price difference d/
		cents	cents	cents
No. 1	50	70	17	8.5
No. 2	20	66	13	2.6
Utility unspotted	15	60	7	1.05
Utility spotted	15	53		
Total				12.15

a/ Data supplied by industry.

b/ 1976 prices.

c/ Prices compared to utility spotted.

d/ Column 1 multiplied by column 3.